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GAS WARFARE

PART II.

METHODS OF DEFENSE AGAINST GAS ATTACKS

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The following pamphlet, entitled "Gas Warfare, Part II, Methods of Defense Against Gas Attacks," is published for the information of all concerned.

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GAS WARFARE.

Part II. Methods of Defense Against Gas Attacks.

METHODS OF DEFENSE AGAINST GAS ATTACKS.

1. GENERAL CONSIDERATIONS.

1. The first and most vital consideration in the protection of troops against hostile gas attacks is the provision of an efficient individual protective appliance to each soldier. Decision as to the type of protective device to be adopted will depend on the following considerations:

(a) The apparatus must be capable of protecting the lungs and eyes for long periods from the gases used, or likely to be used, by the enemy. Protection must, moreover, be furnished against any concentrations of these gases liable to be met with in the field.

(b) It must be of simple design so that—

(i) It will not get out of order from the rough handling it is certain to meet with in the field.

(ii) Even the most uneducated type of soldier can learn to use it quickly and correctly.

(c) The weight must be the minimum possible and the design such that the soldier is not immobilized or seriously discommoded either by carrying the apparatus or wearing it in position.

2. Protection for the respiratory organs and protection for the eyes can obviously be kept separate, and in the earlier designs of apparatus in all the armies this was invariably done. It has been found more convenient, however, to combine the protection of eyes and lungs in one apparatus as being much simpler for the individual soldier and avoiding the danger of goggles alone being used in cases where lung protection was also needed.

3. Protection of the lungs from poisonous gases can be obtained in two ways: Either an entirely fresh atmosphere is provided for breathing, or else the poisonous gas is filtered out either chemically or mechanically.

4. The former method obviously gives **absolute** protection, and because of this fact many types of oxygen breathing apparatus have been tried at one time or another. These all suffer from two fatal defects: they do not last long

enough, and even the lightest forms are too heavy for the soldier to carry about.

5. The filter type of respirator is the one which has been universally adopted. Within the limits of weight which can be carried by the soldier such respirators do not protect against very high concentrations of gas, but fortunately the concentrations of gas met with in the field are relatively low and probably rarely exceed one part in 500 parts of air. "Filter" respirators to deal with concentrations of this order have been devised by all the armies taking part in the war.

6. In settling the design of a respirator the considerations mentioned in Par. 1 must be weighed to give the soldier the maximum of protection with the minimum of inconvenience. For this reason the standard of protection required must be carefully decided. All the past experience of gas warfare has shown that the concentrations of gas produced in the field are continually increasing, and a respirator which efficiently protected against the earlier cloud attacks would be practically useless today. It is obviously necessary, therefore, that a good respirator should have a very large margin of safety to allow for future developments of gas warfare in the same direction and also to deal with the local very high concentrations met with at present.

7. The chemical filling, also, must be such that it will provide protection not only against gases known to be used or likely to be used, but also against such as are considered unlikely because of difficulty of production, scarcity of raw material, etc. It must also provide the maximum safety against future inventions and developments. These, however, are matters for decision by chemical experts.

8. For the reasons quoted above, the American and British respirators have been given a larger margin of safety than the German respirator, which, though simpler in design, will not protect against as large a number of gases nor against such high concentrations; nor will it last so long.

9. A respirator having been issued to each soldier, he must be taught how to use it to the best advantage and the importance of keeping it in good condition. These are matters of training and inspection and are dealt with fully in the section devoted to training in defense against gas.

10. It must be remembered that in the absence of suitable means of protection the poisonous gases used in war are extremely deadly and the breathing of only very small quanti-

ties of them may cause death or serious injury. This being the case, it is essential that not the slightest time should be lost in putting on the respirator when the alarm is given. Arrangements for giving and spreading the gas alarm must consequently be thoroughly prepared beforehand, both as regards the provision of actual alarm appliances and the promulgation of orders which will ensure every man being given the earliest possible warning. Such alarm arrangements must include not only the troops in the front line, but also those in support and reserve, as the effects of a strong gas cloud may be felt over fifteen miles from the line. Alarm to the rear must therefore be thoroughly arranged and be independent of methods of communication liable to break down during an attack or bombardment.

11. Other defensive methods, such as the protection of shelters and dugouts from gas, the clearing of gas from trenches and dugouts, the protection of arms and ammunition, etc., are also of great importance in reducing casualties. It is essential, however, that all devices adopted should be simple in construction and use and really capable of being employed under field conditions. Similarly, all orders on the subject of gas defense must be consistent with active service conditions, but those which are given **must be enforced to the letter.**

12. It will thus be seen that the whole basis of protecting troops against gas lies: (a) in keeping all appliances in perfect working order; (b) in learning to adjust them rapidly under all conditions; and (c) in ensuring that every man is given immediate warning. These results can only be attained:

(i) BY FREQUENT AND THOROUGH INSPECTION OF ALL PROTECTIVE APPLIANCES.

(ii) BY THOROUGH INSTRUCTION AND TRAINING IN THEIR USE.

(iii) BY EVERY MAN UNDERSTANDING AND COMPLYING WITH ALL STANDING ORDERS ON THE SUBJECT OF DEFENSE AGAINST GAS.

If these measures are effectually carried out, there is nothing to fear from hostile gas attacks. Officers must impress this on their men, as an important object of all anti-gas instruction should be to inspire complete confidence in the efficacy of the devices and methods which are adopted.

II. EARLY METHODS OF PROTECTION.

13. The first German gas attack made against the British and French in April, 1915, found the Allies entirely unprepared and unprotected against poisonous gas. Steps were immediately taken to improvise protective devices and to supply respirators for all front line troops.

14. Among the improvised respirators used were gags made with rags or handkerchiefs and soaked in water or washing soda solution, handkerchiefs filled with moist earth, etc. One suggestion was to use bottles with the bottom knocked off and filled with moist earth, the user to breathe in through the neck of the bottle and out through his nose.

It was not necessary to use such methods for long, as an appeal to the women of Britain and France to make respirators of cotton wool in a gauze envelope met with such instant response that by the time of the next attack on May 10th, directed against the British at Hill 60, every soldier had a respirator of some kind. These respirators were kept moist with water, soda solution or "hypo" solution and had to be dipped and wrung out before use.

(A) EARLY BRITISH RESPIRATORS AND HELMETS.

15. **BLACK VEILING RESPIRATOR.**—This was the earliest type of respirator officially issued to the troops, and consisted of cotton waste enclosed in a length of black veiling. (See Fig. 1.) The cotton waste was soaked in a solution of:

Sodium thiosulphate	10 lbs.
Washing soda	2½ lbs.
Glycerine	2 lbs.
Water	2 gals.

The glycerine was put in to keep the respirator moist, thus obviating the need for dipping before use.

The respirator was adjusted over the mouth and nose, the cotton waste being moulded to the shape of the face, and the upper edge of the black veiling pulled up so as to protect the eyes.

These respirators were much used in the attacks of May 10th and 12th, 1915, and were found reasonably efficient against the low concentrations of chlorine then used, but they were difficult to fit exactly to the face and the cotton

Fig. 1.

The Black Veiling Respirator.

waste had to be frequently shredded out to prevent it becoming lumpy.

16. "HYPO" HELMET.—The gas helmet in its original form consisted of a flannel bag soaked in the same solution as was used for the veiling respirator and was fitted with a pane of mica to act as a window. The helmet was tucked down inside the jacket, which was then buttoned up tightly around the neck.

This form of protection had many advantages. It was very simple to use and experience in the attack of May 24th showed it to be very effective against chlorine in the field, though some casualties were caused by the mica pane becoming cracked. In later types the mica window was replaced by celluloid, and later still by glass eyepieces set in metal rims.

17. P. AND P. H. HELMETS.—As it became apparent in the summer of 1915 that the gas phosgene was likely to be used by the enemy in future attacks, and as the "hypo" helmets did not protect against this gas a new form of helmet was adopted. This helmet was soaked in an alkaline solution of sodium phenate containing glycerine, and was called the P. Helmet. (See Figs. 2 and 3.) It protected against three parts of phosgene in ten thousand of air. Since the solution used attacks flannel, two layers of flannelette were used instead and the helmet was fitted with an expiratory valve, partly to prevent a man from breathing any of his own breath over and over again, and partly to prevent unnecessary carbonation of the alkali.

Later on the protection against phosgene was further strengthened by the addition of hexamethylene tetramine (Urotropine), the other ingredients remaining the same. Thus modified, the helmet (the P. H.) protects against one part of phosgene in 1,000 of air and is still used in the British Army for the convenience of troops in the "Precautionary Zone," i. e., between 5 and 12 miles from the front line.

18. GOGGLES of various types were formerly used in the different armies for protection against lachrymators. The last British type had glass eyepieces and made a good fit around the eyes by means of rubber sponge. (Fig. 4.) They gave an excellent protection against lachrymators and were intended for use only after a lachrymatory bombardment

when the concentration was still sufficient to affect the eyes without causing respiratory distress. It was found, however, that they were frequently used during a bombardment and at other times when the respirator should have been worn owing to the presence of real poison gases. They were consequently withdrawn.

An attempt was made to include goggles in the P. H. helmet and a special helmet based on this principle (the P. H. G.) was issued to artillerymen, etc. Its chief objection was the increased time necessary to put it on, and it was discarded previous to the box respirator being adopted.

19. The helmet form of respirator as latterly used by the British suffered from the following disadvantages:

(a) It deteriorated from exposure to air.

(b) Practically the limit of protection obtainable by this type of respirator had been reached. It was incapable of further development.

(c) It had a peculiar smell and when very wet occasionally burned the foreheads of the men.

(d) It did not give good protection against lachrymators, etc.

(B) EARLY GERMAN RESPIRATORS.

20. The first German respirators were simple pad respirators soaked in a sodium thiosulphate-sodium carbonate solution. Each soldier was provided with a bottle of this solution (Schutzsalzlösung), wherewith to moisten his respirator from time to time.

These pads were replaced by a small compact respirator made of absorbent cloth soaked in "Schutzsalz" solution and shaped like a snout, which fitted over the mouth and nose, the latter being closed by means of a steel spring. Many of these snout-respirators were still in use when the British made their first gas attack at Loos in September, 1915, and the troops using this form of protection were among those most seriously affected by the attack. About this time the Germans started the use of their present type of respirator (see par. 33), which has the advantage of protecting against lachrymators as well as chlorine. Later on it was modified so as to protect against phosgene also.

(C) OXYGEN BREATHING APPARATUS.

21. In the early days of gas warfare, when the individual soldier was provided with protection only against chlorine, etc., all the armies furnished their machine gunners and other specialists with oxygen breathing sets, so that in the event of an unexpected gas being used it would be possible to hold the line by their aid. Forms of this apparatus are still used for rescue work and in mine galleries and dugouts which have been fouled by poisonous explosion gases. (See par. 171.)

22. Two types of oxygen breathing sets have been used in the present war:

(a) Apparatus containing a reserve supply of oxygen under pressure. This is the co-called "oxygen helmet," often used in mine rescue work. The main features of the apparatus consist in:

(i) A rubber bag or bags into which and from which the wearer breathes.

(ii) A steel cylinder or cylinders containing compressed oxygen which feeds into the bag through a reducing valve.

(iii) Several pounds of sodium hydroxide in the form of sticks, granules or plates, carried either in the rubber bag or in a metal box connected with it. This alkali absorbs the carbon dioxide exhaled.

Apparatus of this type, known as the "Selbstretter," is still in use by the Germans for rescue work, but with limited distribution, as follows:

Infantry Company	3
Pioneer Company	25
Battery	3
Medical Company	20

For each apparatus a reserve oxygen cylinder and a reserve potash cartridge are kept in the dugouts. The apparatus of this type used by the British is called the "Salvus set" and is now reserved entirely for mining operations.

The complicated nature of this type of apparatus, its weight and the necessity of reserve cylinders of oxygen will prohibit its general adoption and limit its use to special conditions.

(b) Apparatus in which oxygen is generated from a chemical

Fig. 2.

The P. H. Helmet.

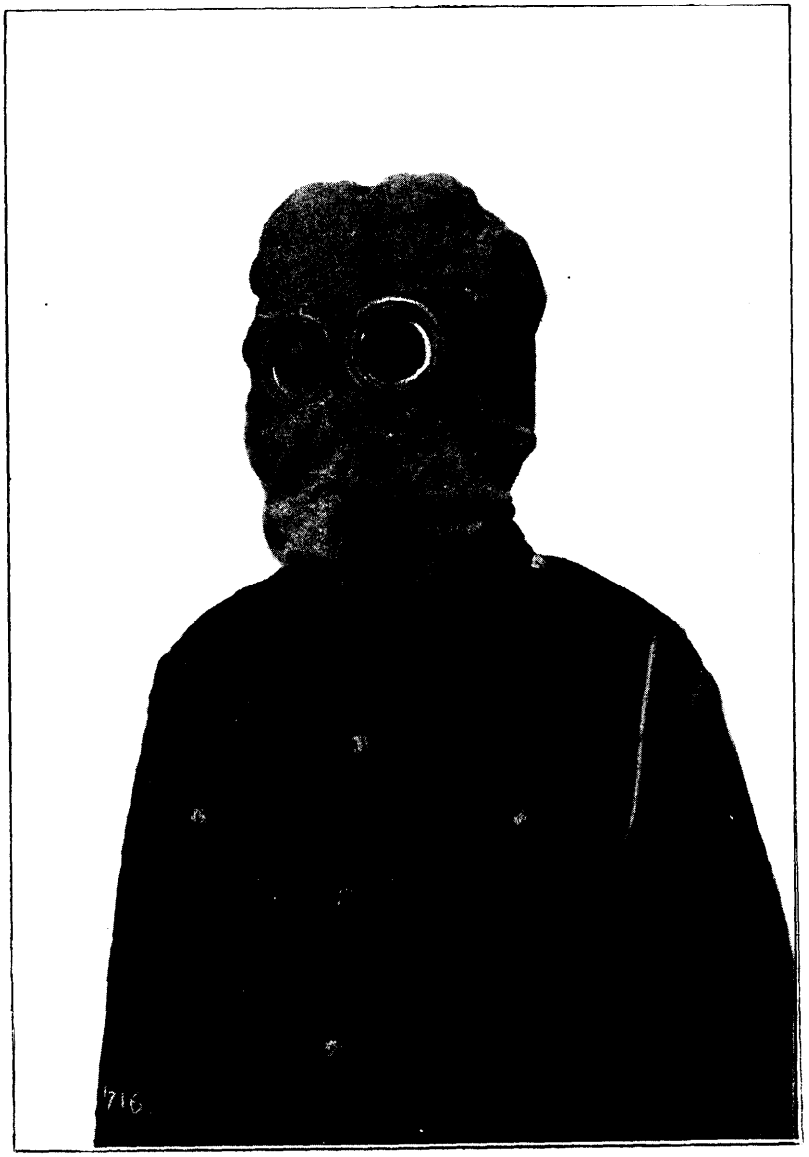

Fig. 3.

Method of Wearing the P. H. Helmet.

A mixture of potassium and sodium peroxides is used in this apparatus. The moisture in the breath of the wearer liberates oxygen from the peroxides and the alkalis remaining absorb the carbon dioxide exhaled.

This method is very attractive, but in practice has a number of disadvantages. Among these may be mentioned the great amount of heat produced when oxygen is liberated from sodium peroxide by water vapor, and the foaming of the material and the resulting blocking of the air ducts.

To these may be added most of the disadvantages under (a). An apparatus of this type has been used, however, by the French.

(D) OTHER EARLY METHODS.

23. When gas defense methods were first beginning to be organized, a number of procedures were recommended for combating the gas cloud. Among them were the building of fires on the parapet, and the use of black powder hand grenades or high explosive shells, to be thrown into the cloud. Such projectiles are useless for dissipating the gas cloud or reducing its noxiousness. Infantry fire is, of course, valueless.

For a long time the Germans placed great reliance on the use of fires for raising and dissipating hostile gas attacks. These fires were built in the firing trenches or in special shallow trenches dug in front. Experiment has shown that this method is useless for combating a gas cloud and the Germans have now given it up.

III. PRESENT-DAY MASKS.

(A) THE AMERICAN RESPIRATOR.

24. With the exception of certain minor changes the respirator adopted for use in the American Army is essentially the small box respirator used by the British.

The following are the important features of this respirator:

(a) The wearer inhales and exhales through the mouth, the nose being closed.

Fig. 4.

Rubber Sponge Goggles.

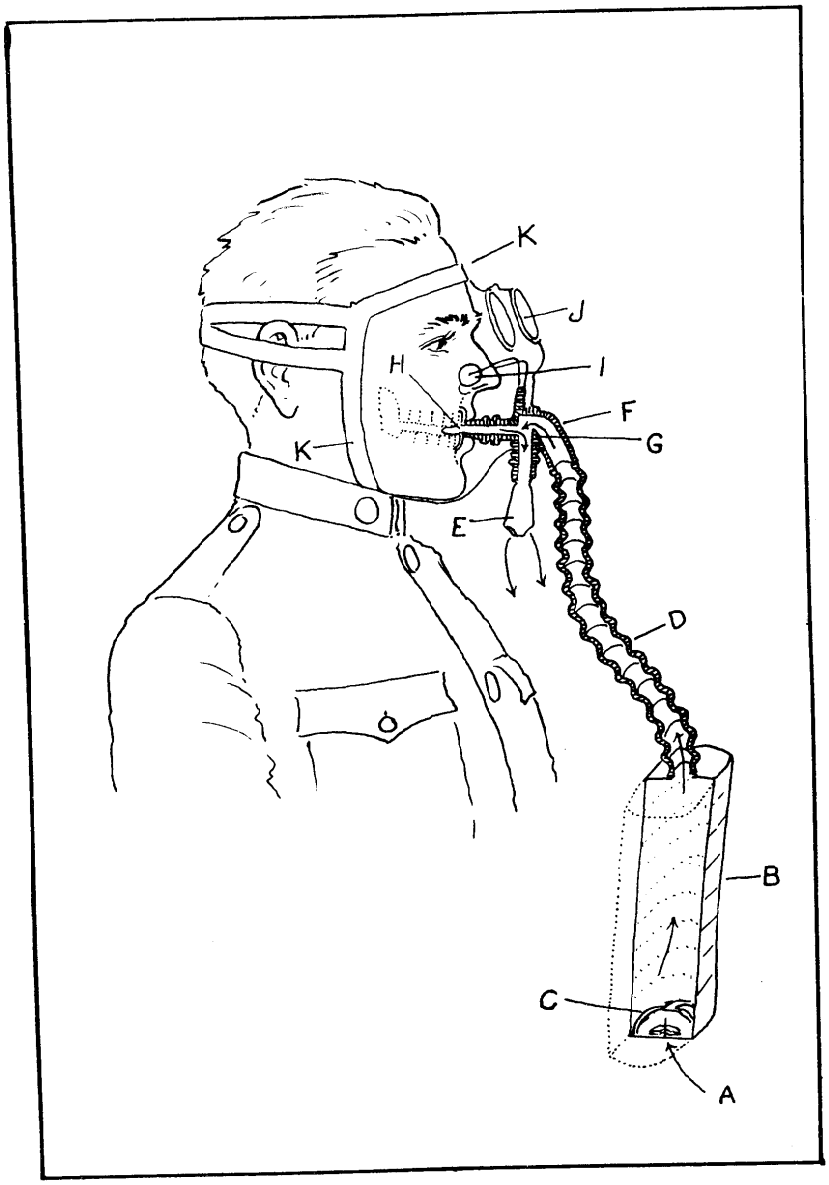

Fig. 5.

The Box Respirator.

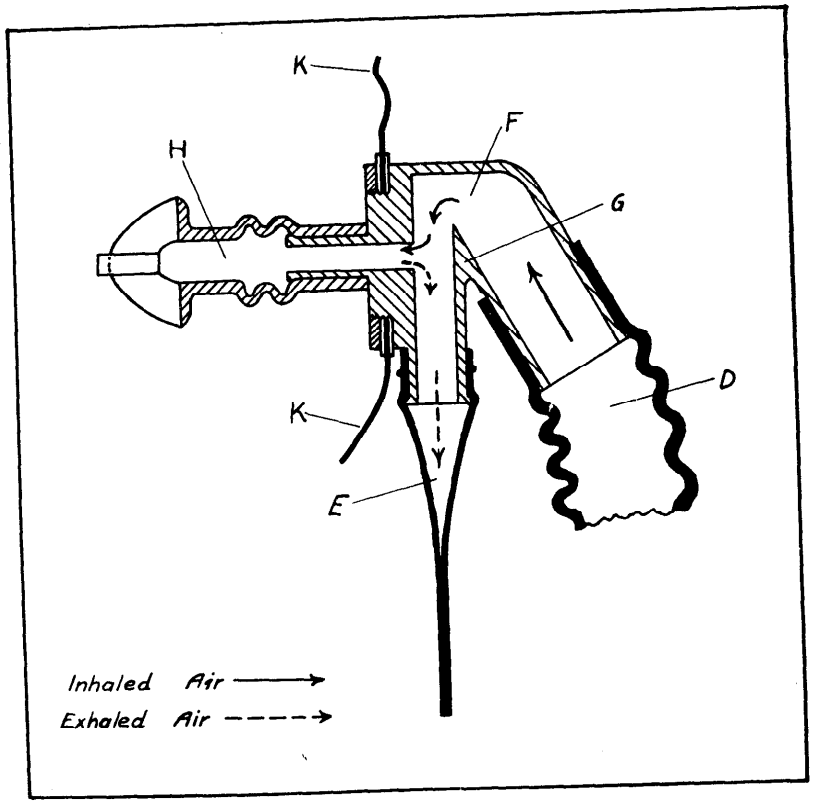

Fig. 6.

The Elbow Tube.

(b) The inhaled air is purified by being drawn through a box of chemicals. These chemicals filter out the impurities.

(c) The exhaled air is discharged through a special valve provided for this purpose.

(d) To protect the eyes from lachrymators and to allow the wearer to speak when the face is covered with a mask.

The details of the respirator are shown in Fig. 5.

The Rubber Inlet Valve (A) is open while air is inhaled—closes when air is exhaled from the lungs.

The Canister (B) is a tinned iron box reinforced with ribs. It contains chemicals that absorb the poisonous gases. These chemicals are packed loosely to permit the passage of air through the canister and supported by the curved wire screen (C).

The Flexible Tube (D) is wired at one end to the canister and at the other to the elbow tube. The tube is corrugated to permit easy extension and prevent kinking.

The Elbow Tube (F) (see Fig 6) joins the flexible tube with the mouthpiece (H). It also carries the outlet valve (E). An important feature of this tube is the baffle (G), which acts as a saliva trap. This allows any saliva that may accumulate to escape through the outlet valve and prevents it from flowing into the canister with resulting deterioration of the chemicals.

The Outlet Valve (E) is made of pure gum rubber. During intake of air at A it remains closed. When air is exhaled, the pressure forces open two slits in the end of this valve and the expired air escapes. There also escapes through this valve some saliva, which, however, the wearer should not allow to escape from his mouth, but should learn to swallow.

A metal guard which encloses and protects the outlet valve has recently been added to the American respirator.

The Rubber Mouthpiece (H), through which the wearer breathes, is provided with a flange which is held between the teeth and the lips. The mouthpiece can be removed from the mouth to enable the wearer to speak without disturbing the fit of the mask.

The Noseclip (I) consists of two rubber pads held by a wire spring. It closes the nostrils, thus making it impossible

to breathe any air except that which has passed through the canister into the mouth.

The Eyepieces (J) are made of celluloid or of specially prepared glass. They should be treated with anti-dimming composition to prevent their becoming clouded by the deposition of particles of moisture. If necessary they can be cleaned without removing the respirator by means of folds in the material.

The Facepiece (K) is a rubberized fabric impervious to gases. It fits closely at the sides and is held in position by the elastic bands, which pass over the head to the full extent allowed by a non-elastic retaining tape.

25. The complete respirator is carried in a special satchel which is divided into two compartments—one of which holds the canister and the other the mask. The canister rests on a wire platform which raises it from the bottom of the satchel and allows the free access of air.

Each man is provided with a respirator which has been fitted to his face. He must be made to realize that this appliance is PERSONAL EQUIPMENT, that it is of IMPORTANCE SECOND ONLY TO HIS WEAPONS, AND THAT HIS LIFE MAY DEPEND ON LOOKING AFTER IT AND KEEPING IT IN GOOD ORDER.

The respirator will protect the wearer against all poisonous gases with the exception of mine and explosion gases, and will not become exhausted for hours, even in concentrations of gas normally unobtainable in the field.

In order that the mask may fit the face closely, every man must be clean shaven except that he may wear a moustache.

26. Method of Use.—The satchel containing the box respirator is carried outside all other equipment. When over two miles from the front line it may be worn slung over the right shoulder, but men in the trenches or proceeding thither must carry it slung on the chest, as in the "Alert" position. The flap of the satchel with the snap fasteners must always be toward the body.

It must be remembered that the box respirator can be worn in gas for many hours on end without losing its efficiency or causing any distress. It may be breathed through in drills for a period of one hour per week for an indefinite time without impairing its efficiency. This is in addition to initial drills when the respirator is first issued and fitted.

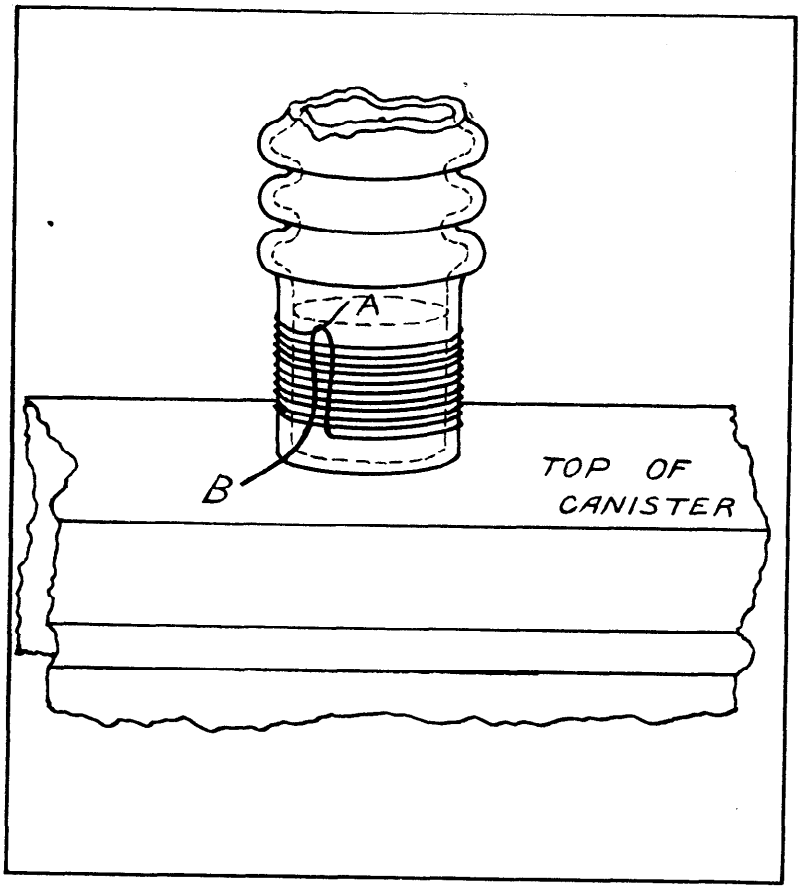

Fig. 7.

Fastening a New Canister to the Flexible Tube.

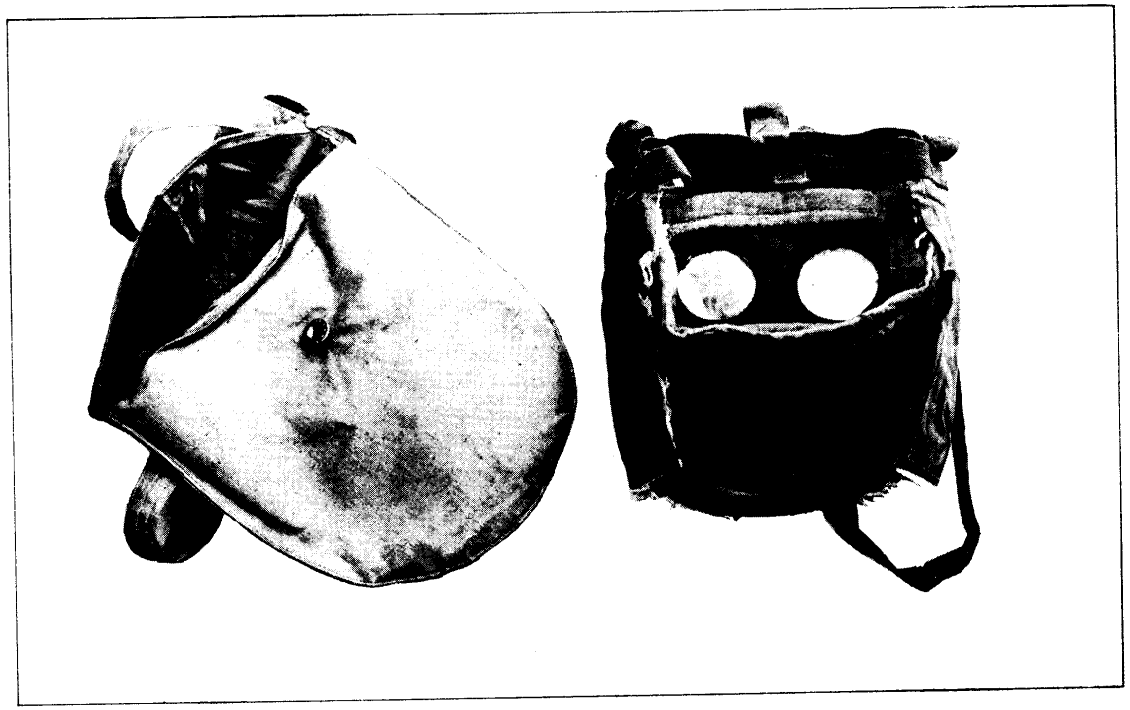

Fig. 8.

The French M-2 Mask (Rear View).

Fig. 9.

The French M-2 Mask (Front View).

Fig. 10.

The Tissot Box Respirator.

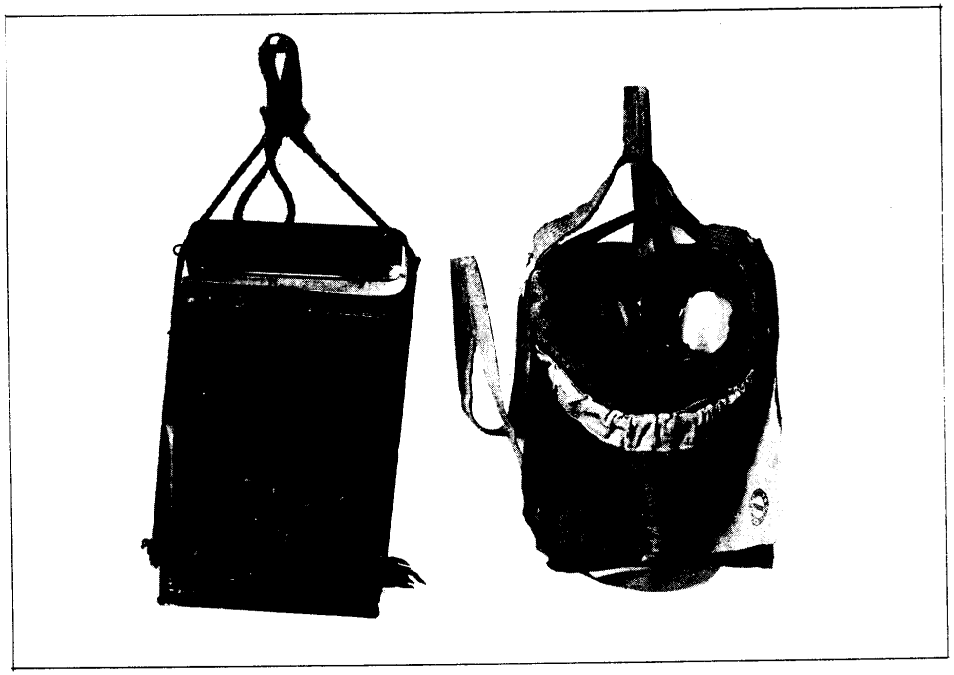

Fig. 10A.
The Italian Mask

Fig. 10B.
The Russian Respirator

27. Local Repairs.—A small repair outfit, consisting of pieces of adhesive plaster, is included, with a record card, in each satchel.

Small perforations in the facepieces can be temporarily repaired by applying pieces of the adhesive plaster to the perforation, both inside and outside the mask. They should be large enough to overlap the hole all around. Box respirators so repaired should be exchanged as soon as possible. The repair is only intended to make them safe until a new respirator can be obtained.

No other local repairs are permitted and all defective respirators must be handed in and new ones obtained.

Box respirators which have fallen into water must be exchanged as soon as possible.

28. Record of Use.—The correct keeping of records as to hours of use of the respirator by means of entries on the small card forming part of the repair outfit is a matter of the greatest importance, as these records form the only guide as to whether the canisters should or should not be replaced. Decision as to replacement is made on the advice of the Divisional Gas Officer. The approximate time during which the respirator is worn in shell gas or cloud gas must be correctly recorded. In order to allow for the total time during which a respirator has been breathed through, it should be assumed when estimating its condition that it has been worn for one hour per week for drill purposes.

29. Exchange of Respirator Canisters.—Exhausted or damaged respirator canisters should be replaced as follows:

(i) Remove the canister from the satchel, take off the adhesive tape from the lower end of the rubber tube, and carefully lever off the latter by means of the special tool provided for the purpose. Great care must be taken not to injure the rubber in doing this.

(ii) Remove the plug from the neck of the new canister, wet the neck slightly and insert it in the rubber tube, the end of the tube coming right down to the shoulder of the canister. See that the canister lies in the correct position so that the tube will not be twisted when the facepiece is put on.

(iii) Bind the rubber tube to the neck of the canister by

means of the string provided, in the manner shown in Fig. 7. The end (B) is caught up in a long loop and the string wound tightly round the neck in an upward direction. Pass end A through the loop, then pull B down tightly and tie A and B in an ordinary reef knot.

(B) FRENCH MASKS.

30. THE M-2 MASK.—While certain types of box respirators have been used in the French Army for special purposes, the main protection at present is obtained from the type (M-2) illustrated in Figs. 8 and 9. This consists of a mask made of a number of layers of muslin impregnated with various absorbent chemicals. It fits the face tightly and as a consequence the inhaled air can only be obtained by drawing it in through the pores of the impregnated fabric. There is no outlet valve. The exhaled air must make its escape through the fabric. The eyepieces are made of a special non-dimming celluloid.

The front of the respirator is protected by a flap of waterproof fabric, which protects the mask from rain and consequent deterioration of the absorbent chemicals.

This mask is at present used as a reserve by the American Expeditionary Forces for the convenience of troops in the "Precautionary Zone," i. e., within 5-12 miles of the front line.

31. TISSOT BOX RESPIRATOR (Fig. 10).—The Tissot apparatus, which is issued by the French Army to artillerymen, stretcher bearers and certain other specialists, is a box respirator based on the filter principle. It consists of a canister, a rubber mask and a tube for connecting these two, the canister being carried on the back.

It differs from the American and British respirators in the following particulars:

The wearer can breathe through the mouth or the nose, consequently there is neither mouthpiece nor noseclip. The inhaled air enters the mask from two tubes which open directly under the eyepieces and allow the air to sweep across them. This prevents moisture from condensing on the eyepieces, so that the vision is not clouded. The exhaled air escapes through a simple outlet valve.

32. The Tissot mask has the following advantages:

The facepiece is tight and comfortable.

The eyepieces do not become dimmed.

There is no difficulty in speaking, since there is no mouthpiece.

It suffers from the following disadvantages:

The wearer depends entirely on the fit and strength of the facepiece. If this leaks around the edges or becomes ruptured he becomes a casualty.

The canister is heavy and not easily carried.

The whole apparatus is too complicated and fragile to trust in the hands of the average soldier.

(C) THE ITALIAN MASK.

This mask, which is shown in Fig. 10A, is a modification of the French M-2 type. It is kept in a tin box which can be carried at the slung position by means of a cord.

(D) THE RUSSIAN RESPIRATOR.

32b. This mask, which is shown in Fig. 10B, consists of a box canister to which a rubber face piece is attached direct. The face piece has neither mouthpiece nor nose-clip. It is also not provided with retaining tapes. It is made of a good quality of rubber, with a considerable amount of elasticity so that it fits the face tightly. When worn in position it completely covers the top of the head, the face and the ears. The canister, which is filled with charcoal, is provided with an inlet and an outlet valve, both of which are shown at the bottom. When not in use these valves are covered with rubber caps. The mask is very uncomfortable. In numerous instances soldiers have been so discommoded by it that they have removed it in gas.

(E) THE GERMAN RESPIRATOR.

33. The German respirator is similar to the American type in that the inhaled air is purified by passage through a canister filled with chemicals. There is a facepiece, but no noseclip, mouthpiece nor valves. The exhaled air passes out through the canister, which is attached directly to the facepiece. Figs. 11 and 12 show the latest type of German mask. The facepiece is made of leather. The elastic bands of the British and American masks are replaced by small spiral steel springs encased in cloth. The eyepieces are of glass

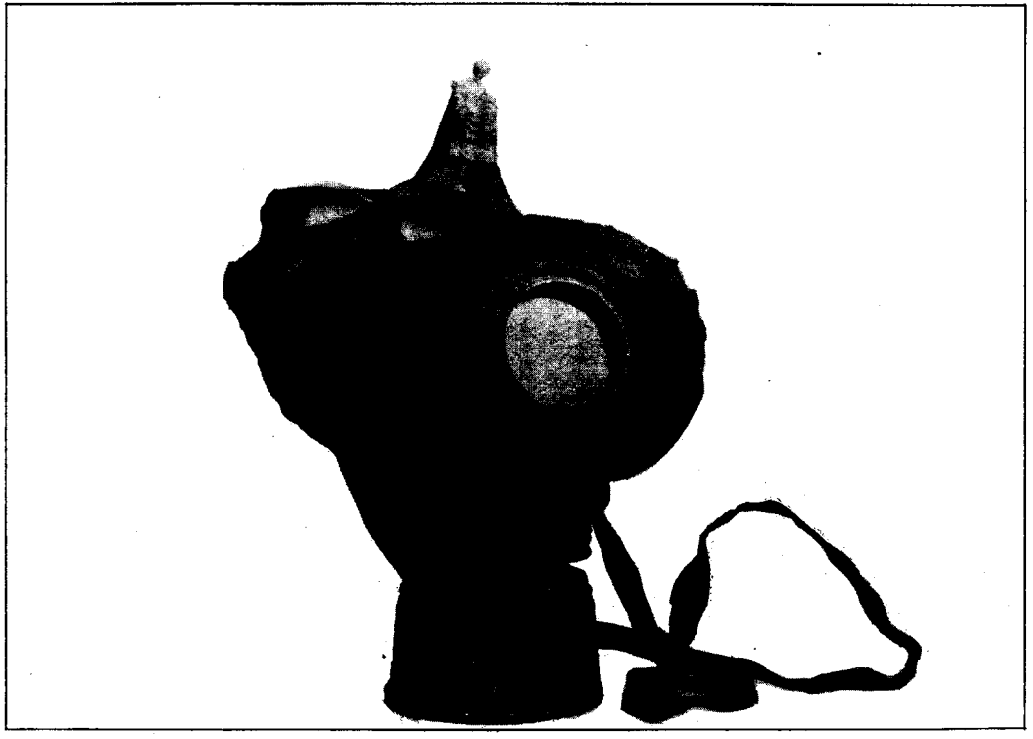

Fig. 11.
The German Respirator.

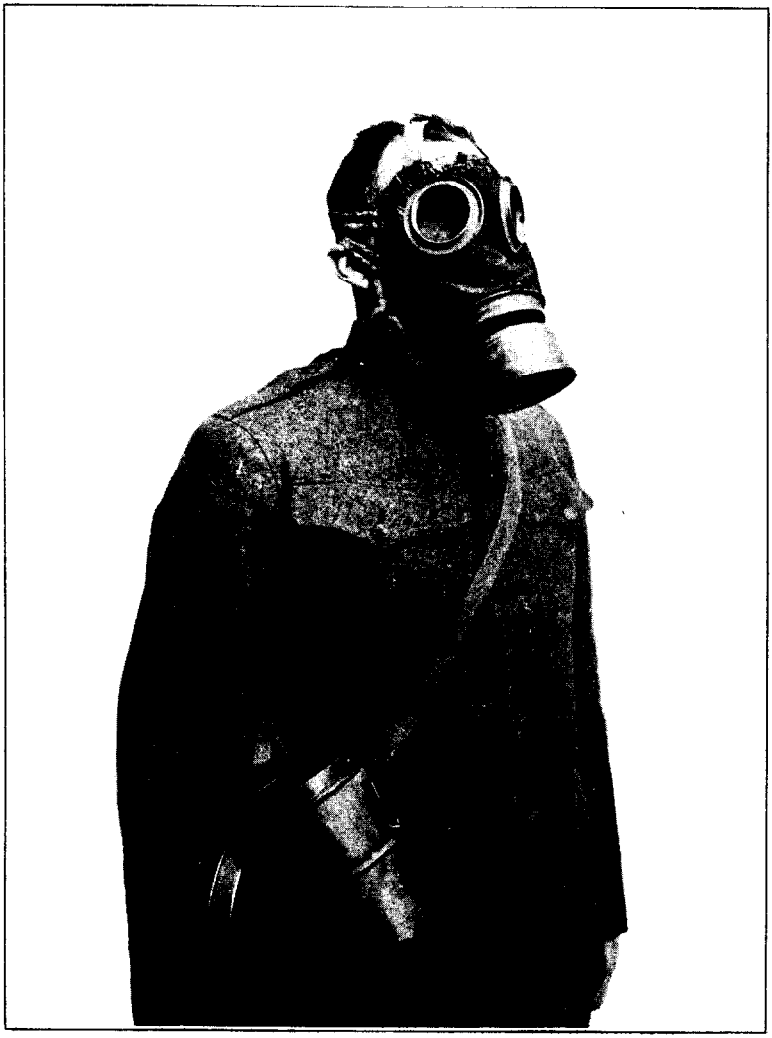

Fig. 12.

provided with a gelatin disk to prevent dimming. Each soldier is furnished with several spare disks. The eyepieces are further protected by a light metal frame, easily seen in the right eyepiece of Fig. 11.

The canister screws on to the facepiece, thus permitting each soldier to carry an extra one for emergency. The canisters issued with the first masks contained but one layer consisting of granules of baked earth saturated with potassium carbonate and covered with fine charcoal. Later another layer of charcoal was added, and the present canister, of which a cross section is shown in Fig. 13, contains three layers. The Urotropine in layer C absorbs phosgene. A detailed description of this respirator is given in pars. 50-60.

34. In comparison with the American respirator the German mask suffers the following grave disadvantages:

(a) The absence of noseclip and mouthpiece forces the wearer to depend entirely on the fit of the facepiece and on its freedom from tears, holes, etc.

As a consequence a flaw or a hole in the fabric or an opening between the face and the edge of the mask means that the wearer becomes a casualty.

(b) The existence of a considerable "dead" space which forces the wearer continually to breathe a certain amount of his own expired air. This causes an increased rate of breathing (with consequent greater danger of passage of gas) and discomfort, owing to increased pulse and body temperature.

(c) Deterioration of the chemicals in the canister, due to the continual passage of expired air.

(d) Mechanical difficulties caused by the canister being hung from the facepiece. The weight of the canister tends to pull the mask away from the face.

(e) Permeability of leather to certain gases.

(f) Shorter life, owing to smaller canister.

(g) If leather becomes wet it tends to dry hard and the mask will not fit.

35. NEW GERMAN ANTI-GAS APPLIANCE.—A new emergency device for gas defense which has recently been developed by the Germans is shown in Fig. 14. It consists of a mouthpiece, with an adapter which can be screwed to the breathing drum of the German respirator. A wire noseclip is attached by a cord. The mouthpiece is made of

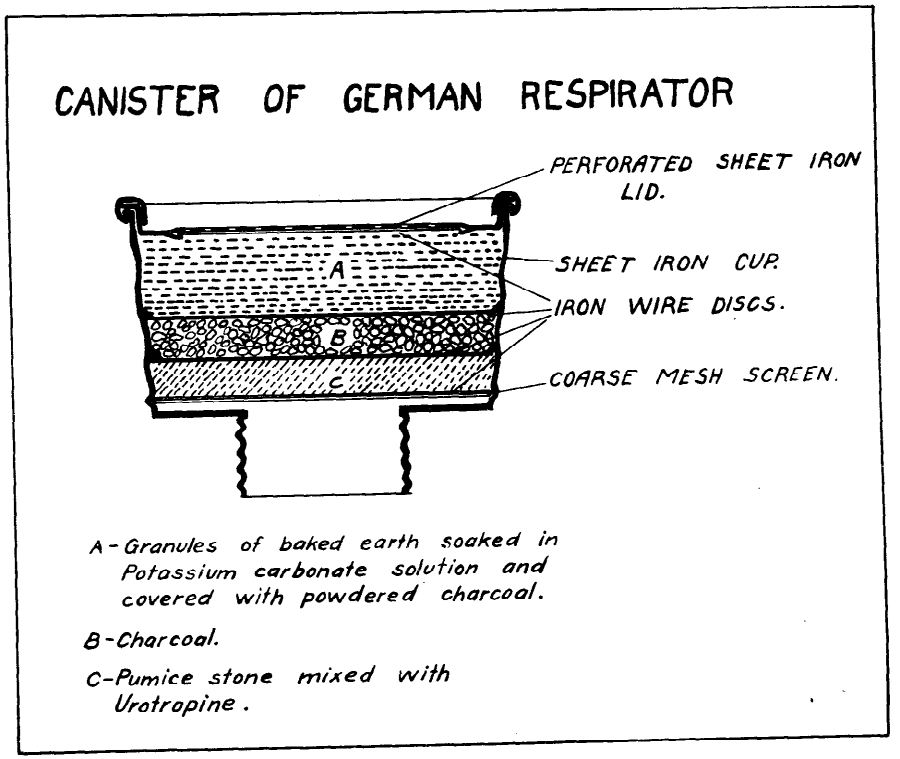
CANISTER OF GERMAN RESPIRATOR
PERFORATED SHEET IRON LID.
SHEET IRON CUP.
IRON WIRE DISCS.
COARSE MESH SCREEN.
A
B
C
A-Granules of baked earth soaked in Potassium carbonate solution and covered with powdered charcoal.
B-Charcoal.
C-Pumice stone mixed with Urotropine.

Fig. 13.

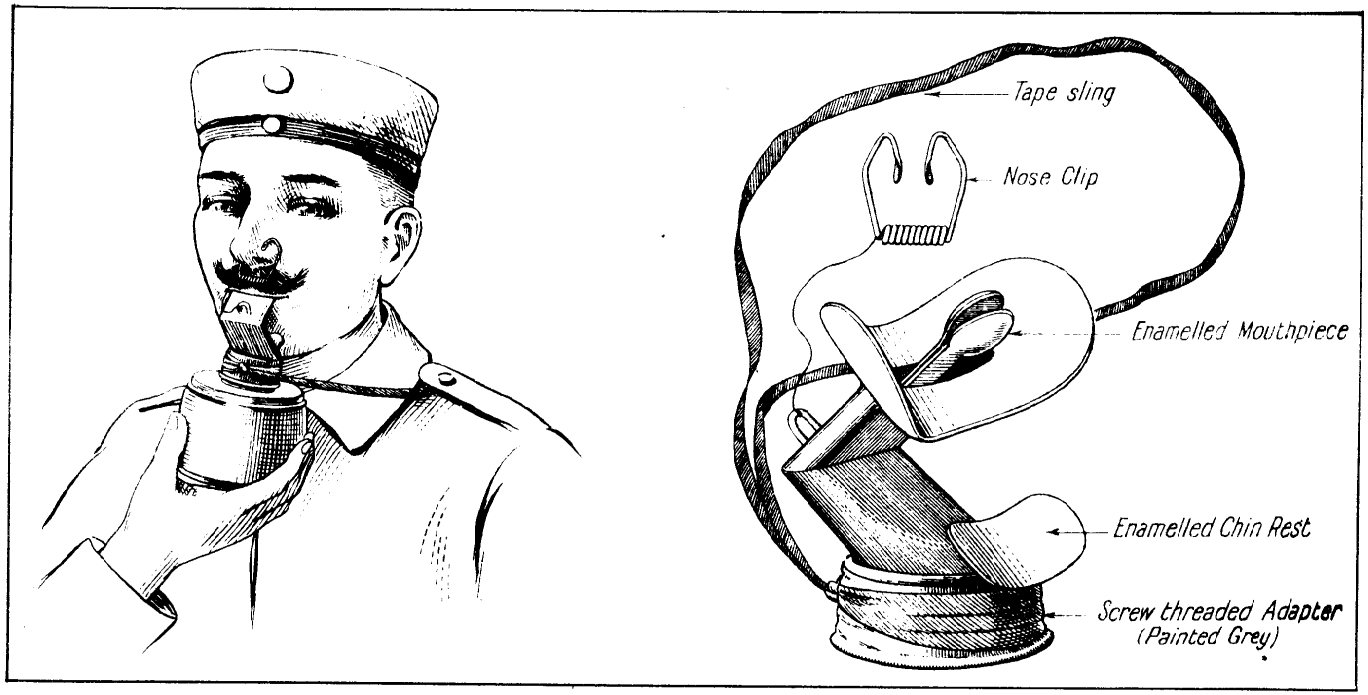

Fig. 14.

New German Anti-Gas Device.

enameled metal (probably owing to shortage of rubber), and is similar to that used by the enemy with the Draeger oxygen breathing apparatus (Selbstbretter).

The appliance is intended:

(a) For the use of observers and gun layers, who require full use of their eyes.

(b) As an improved method of using the spare canister when the first becomes exhausted.

(c) For attachment to the spare canister when hung round the neck, so that immediate protection can be obtained in case of a projector attack.

The disadvantages of the appliance are:

(i) It affords no protection against lachrymatory gas without the use of goggles.

(ii) It is unsuitable for men on the move, as there is little support for the canister.

36. GERMAN GAS DEFENSE APPLIANCES.—Translation from Orders of the 3rd Bavarian Infantry Division, 1917.)—All our troops are now supplied with the Army Mask. This is a face mask and covers only the face and not the whole head; consequently the space between the head and the mask—the so-called "dead space"—is very small. The smaller the dead space the easier it is to breathe.

The Army Mask provides complete and lasting protection against both our own and hostile battle gases. The air which is breathed through the mask is filtered from all harmful mixtures.

37. From the nature of the mask—i. e., an air filter—it is limited in its application: the mask must not be put on for use in places in which there is insufficient oxygen for normal breathing, for example, in gassed mine galleries and mine shafts. In these cases the oxygen breathing apparatus provided for such personnel is used.

38. The principal components of the mask are the facepiece with its mouth ring, and the canister (Einsatz); other accessories are the carrying tape for hanging the mask around the neck and the elastic head bands, especially arranged for holding up the canister in front of the mouth.

The facepiece consists of an impervious material which by treatment with rubber solution is rendered absolutely gastight. There are three openings in the facepiece, two of which are fitted with metal rims for the eyepieces, and the

third for the mouth ring. The mouth ring is fitted with a threaded socket containing a washer. The canister can be screwed into this socket.

39. The facepiece becomes useless when it is defective, either in the material, in the sewing, the eyepieces, or the mouth ring. The following are the chief defects:

A. In the Fabric:
   1. Holes.
   2. Tears.
   3. Abrasions.
   4. Faults in weaving.
   5. Poorly rubberized.
   6. Rust, oil or fat spots.

B. In the Sewing:
   1. Folds not sewn in.
   2. Varnish broken off in such a way that the actual stitches are visible.

C. In the Eyepieces:
   1. Cracked or broken windows.
   2. Windows so loose that they shake about.
   3. Made gas tight with shellac instead of pressure.
   4. Rough edges on frame.

D. In the Mouth Ring:
   1. Holes in the metal.
   2. Bad screws.
   3. Rubber washer missing.

All the above named defects influence in a greater or less degree the tightness of the mask. It is frequently found that the presence of one or the other of these faults shows the mask to be useless only after lengthy exposure in a gas attack. **Masks with even one of these defects must immediately be discarded for use in the field.**

The final decision as to whether or not a mask is suitable for use in the field can be made only as the result of testing in gas chamber.

40. The canister consists of a light pressed metal case which contains the materials for absorbing and fixing the gas. As the canister contains three different materials, in three layers, it is known as the "Three Layer Canister." All canisters of later date than 1-6-16 are termed "Leichtatmer." In such canisters the resistance is 50 per cent. lower than in the previous three-layer canister.

41. One canister will protect against gas attacks of many hours' duration. If it falls into water, or is exposed for a very long time in moist air, it becomes useless, because the resistance to breathing is then too great. The wire gauze in the canister rusts because of the moisture, and this stops up the meshes, thus making it very difficult to breathe. For this reason the canister must be tested every three months with a special apparatus for measuring the resistance to breathing.

All canisters that rattle when shaken, or in which the rim of the perforated cover has become so loose that the cover can be turned or removed, must be discarded.

All canisters which have allowed even the slightest trace of gas to come through, during a smoke or gas attack, or when in the gas chamber, and also canisters which have been used for practice, must no longer be employed during an attack.

42. The life of the canister for use in the trenches must be the maximum. The method of carrying the mask depends on the danger of a gas attack. Outside the danger area, the mask is carried in the canvas container; the mask with one canister tightly screwed in, being placed in the gas alert box, and this together with the spare canister placed in the canister holder. The latter must be so worn and affixed to the equipment that it can be easily opened and the mask quickly taken out. Within the danger zone the mask with the canister in position is carried in the gas alert box, which is suspended over the shoulder.

43. In the "extreme" gas alert period the mask is carried by the carrying tape only. During rainy weather care must be taken to protect the canister from becoming wet. When the mask is carried in this way, smoking must be absolutely prohibited, as the blowing of sparks or hot ashes may burn holes in the material or damage the rubber.

The "extreme" gas alert period is ordered when it is probable that there will be a hostile gas attack and especially in places where the gas cylinders are built in and gas projectiles (shells and bombs) are stored or carried.

44. The putting on or taking off of the mask is to be done with great care. Everyone must be able to put on his mask quickly and correctly in six seconds. Too vigorous adjust-

ment of the mask should be discouraged, as it is apt to damage the mask. It is best that the adjustment be made in separate movements which follow in quick succession. Every movement must be made cool and collected. The correct method of putting on the respirator must be drilled into the men so that it becomes first nature to them.

45. The anti-gas mask must be regarded as part of the permanent equipment of a man. In order to avoid a dangerous change each man must write his name on the mouth ring, on the gas alert box and on the canvas container. It must not be written on the fabric of the mask, as thereby its tightness against gas might be affected.

46. It must be made perfectly clear to each man that his gas mask fits him, and him only; that it is his sole protection against enemy gas, and that only a mask of which the various parts are in perfect condition is sure to give protection. The gas mask is a more delicate instrument than the rifle; it must therefore be looked after even more carefully.

47. A defective mask is more dangerous to its owner than none at all. A man without a gas mask can protect himself to a certain extent, but one with a defective mask believes that he is protected and consequently becomes a casualty. By means of training, each man must be made to realize the importance of his gas defense equipment. He must look after them, inspect them, and immediately report all defects or losses.

48. In the front line the gas mask must be carried everywhere—when on sentry duty, when in working quarters, or engaged in carrying or in marching. In this way it is possible to be absolutely prepared against a "surprise gas attack," and only thereby are the dangerous exchanges of masks avoided.

49. Men wearing spectacles must remove their glasses before putting on a gas mask unless they are provided with specially protective spectacles, fastened with tape, as otherwise gas would be likely to penetrate at the point where the bows pass between the edge of the mask and the head. The glasses can be prevented from dimming by previously breathing on them.

A man with a damaged ear-drum must stop the particular ear with wadding, so that no poisonous gas penetrates

through the walls.

50. LEATHER MASKS.—(Translation of Extracts from a Captured Document dated 6th June, 1917, Issued by the German War Ministry.)—Leather is used for making the mask because it is effective in the field and supplies are available.

It is rendered impermeable to gas by treatment with oils. The stiffness of the leather ensures that the facepiece remains open when mask is withdrawn from the box; its adjustment is thus facilitated.

51. As wiping folds are excluded, owing to the stiffness of the leather, anti-dimming discs are provided, which are attached to the inside of the eyepieces. The mask functions without these discs, as they have no protective importance.

52. The dead space in the leather mask amounts to only half that of the rubber mask, owing to the absence of the wiping folds. A further decrease in the dead space is affected by the process of the "tying up" of the mask, which practice must always be carried out. A length of string, for this purpose, is attached to each mask and runs from the mouth ring, between the eyepieces and to the back of the head, serving to raise the drum.

53. For technical reasons the eyepieces are situated somewhat obliquely to the axis of vision, contrary to the rubber mask, and, further, are fitted with stronger rims set farther apart.

The field of vision directly before the face is consequently somewhat diminished, owing to the outer ring of the eyepieces. This has no importance when both eyes are used. When one eye alone is used, as in aiming, etc., the difficulty of vision is obviated by: (a) practice and (b) the process of "tying up," mentioned above, which reduces the obliquity of the eyepieces.

The Eyepieces in the leather mask differ from those in the rubber mask, owing to the introduction of the anti-dimming discs.

54. The impermeability of the mask is, however, previously insured by the "Cellon" eyepieces, which are protected on the exterior by a metal flange. On the inside there is a screw thread for taking a zinc ring to clamp the anti-dimming disc. This zinc ring is fitted with a wire grid to protect the disc. This grid may be partially or wholly removed

in exceptional cases, where men wearing spectacles complain of pressure on the nose.

55. The Anti-Dimming Discs consist of detachable, circular discs, with up-turned edges, of approximately similar diameter to the Cellon eyepieces. They absorb moisture by gradual swelling up and softening at the same time, without becoming opaque. Even when the mask is worn uninterruptedly for six hours, these discs ensure perfectly clear vision, and after that lapse of time the dimming only sets in gradually. (The period varies according to the temperature and time of year, likewise on the nature of the work on which the wearer is employed at the time.) On exposure to the drying action of the air, the discs give up the moisture absorbed and can thus be used continually.

56. Moisture on the discs produced by respiration should be poured off inward, in order to facilitate the drying of the mask and to avoid unnecessary use of the discs. Discs which have become opaque will be changed, but not during a gas attack. While being changed they must not be exposed to the action of rain. They are to be held by the edge, and the eyepieces must be kept horizontal, so that the discs (when clamped) lie in the middle.

57. The mask is issued, for use in the field, with anti-dimming discs already fitted; there are, besides, in a special receptacle in the lid of the box, four pairs of anti-dimming discs, each pair contained in a waterproof envelope. The discs must be so inserted that their upturned edges lying toward the interior of the mask, the lettering on them may be read. In screwing up the zinc ring the rough rim is to be gripped, and not the protective grid.

58. Treating and Testing of Leather Mask.—By kneading the leather with the fingers undue pressure on the chin, owing to the stiffness of the leather, may be reduced.

In taking the mask out of the box, light spots are often noticeable, near which the oil has oozed out. The oil should be rubbed in again and the spots will disappear. Parts of the leather, which have become soiled with grease, must not be wiped with cloth or paper. Re-oiling of the leather is forbidden. The leather stands well against any wear caused by frequent usage. Leather through which light shows is faulty, likewise leather which is half frayed through. If the interior of the leather facepiece has become as rough in texture as

the exterior, the mask is to be changed.

59. While slight defects on the outer edge of the mask are of no importance, defects in the lacquer on the seams render the mask faulty. Faults in the seams of the eye and chin-pieces—i. e., gaps in, or fraying of, the lacquer—also interfere with protection. Particular attention is to be paid to those parts of the seams which run under the eyepieces and mouth-ring.

60. The leather mask with drum is carried in a somewhat larger box, fitted with a double catch to lid (the ordinary press catch and a wire clip).

The use of the canvas wallet is discontinued. The spare drum is carried in a small wallet attached to the belt, and is protected against dirt and damp by a metal cap, which screws into the mouth aperture, and by an easily removable cardboard disc inserted at base of drum.

61. RESISTANCE OF RESPIRATORS TO THE PASSAGE OF AIR. The facility with which air passes through the canister of any of the types of box respirators is obviously of importance from the standpoint of ease of breathing. It is, however, absolutely no indication of the absorbing capacity of the chemicals in the canister. It has been shown that a freshly filled canister may have much the same resistance to the passage of air as one that has been discarded because the chemicals are no longer active.

62. A field apparatus used by the Germans for measuring the resistance of their canisters is shown in Fig. 15.

The apparatus consists of a box with a socket in each end, into which the canister can be screwed. One of these canisters (S) has the standard resistance; the other (X) is the one to be tested. The canisters are connected with a tube (A). This tube is in turn connected with a manometer (B), which is simply a capillary tube containing a liquid. Air can be forced into the system at (A) by means of an ordinary bicycle pump (P). If the resistance in (X) is greater than the standard, the liquid in the manometer will move to the right. If it is less, it will move to the left. Canisters in which the resistance is higher than that of the standard are withdrawn from use.

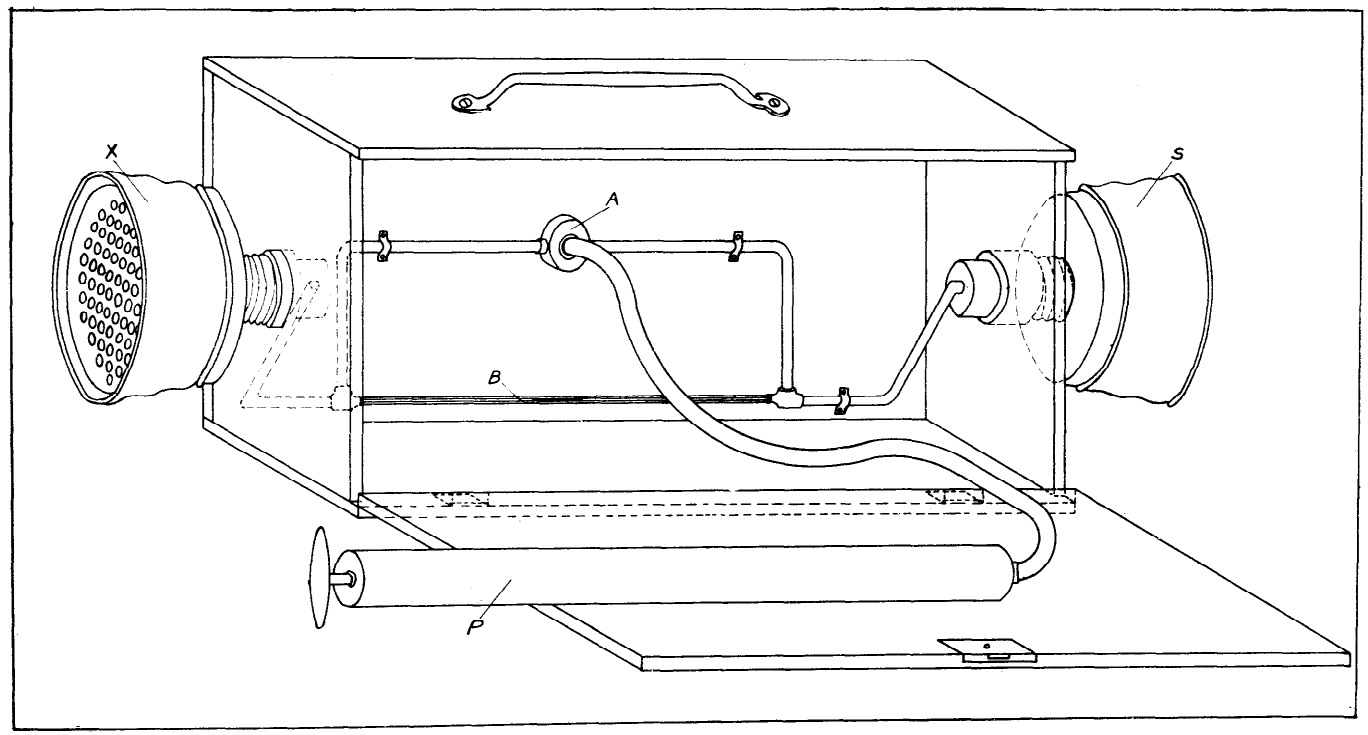

Fig. 15.
Apparatus for Measuring the Resistance of Canisters.

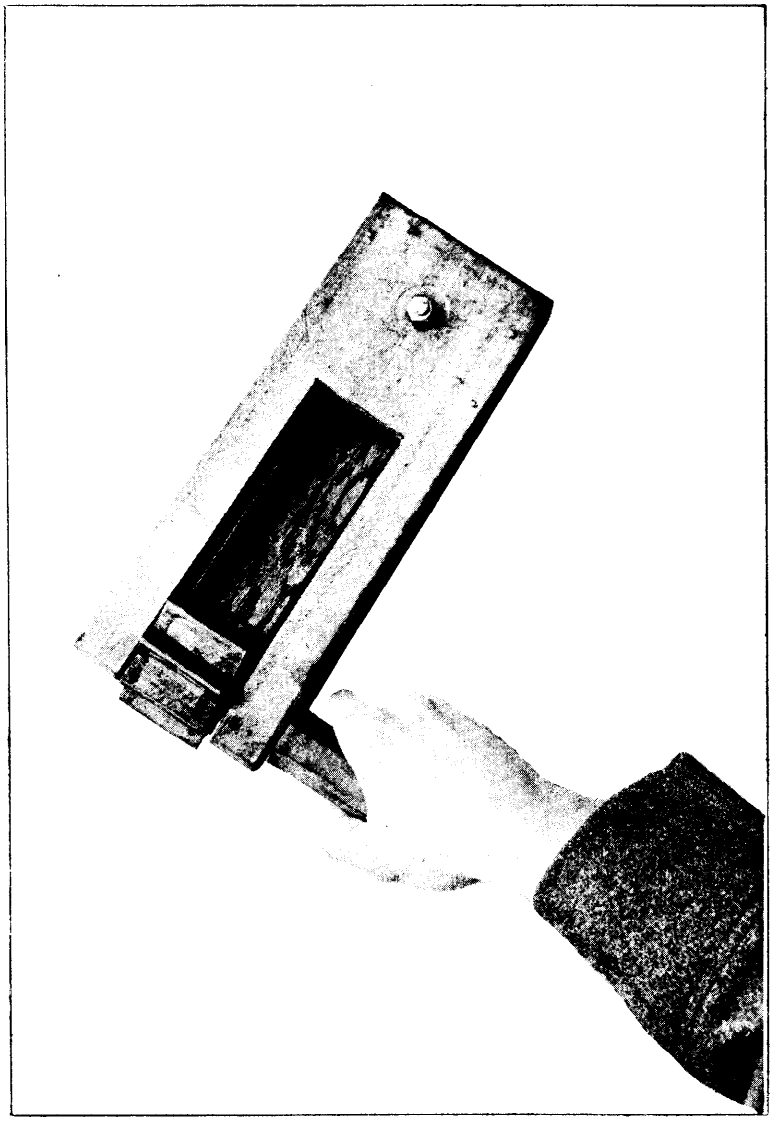

Fig. 16.

Rattle for Giving Gas Alarm.

IV. ANTI-GAS APPLIANCES FOR GENERAL USE.

(A) ALARM APPLIANCES.

63. GAS SHELL AND LOCAL ALARMS.—A local gas alarm must be fitted up at every sentry's post, occupied sap, battery position, etc., for the purpose of rousing men in the immediate vicinity and conveying warning to the sentries in charge of long-distance cloud-gas alarms.

These local alarms should be used for all forms of gas attacks and are particularly useful for giving notice of the use of gas shells. No reliance can be placed on devices giving the alarm involving the use of the lungs—e. g., bugles or whistles.

No standard pattern has been adopted for these local alarm devices. Klaxon horns, gongs (shell cases), large bells, 2-ft. lengths of steel rail or triangles made of steel rail and policemen's rattles (see Fig. 16) are all in use. Klaxon horns are generally unobtainable in sufficient quantity. Shell cases are usually too weak and triangles too cumbersome. The best alarms undoubtedly are the policeman's rattles, which are especially useful for employment at battery positions, and the lengths of steel rail and bells.

64. It is essential that gongs, steel rails, etc., be suspended in such a way that they swing free and do not rest or hit up against the parapet. Bells should be at least 7 inches in diameter at the base and should be fastened to a cross beam so that they do not sound when brushed against. They should be rung by pulling the clapper, as a ship's bell. The great advantage is that they are complete in themselves and do not require separate strikers.

65. It has been suggested as a suitable alarm that a triangle of light steel be mounted in such a way that it can be beaten by working a treadle. It can thus be sounded by a sentry while he is putting on his respirator. The disadvantage of this and similar devices is their cumbersome nature, difficulty of provision in very large numbers and the possibility of their getting out of action under service conditions.

66. For the purpose of rousing men in dugouts it is a good plan to have a bell installed in the dugouts which can be

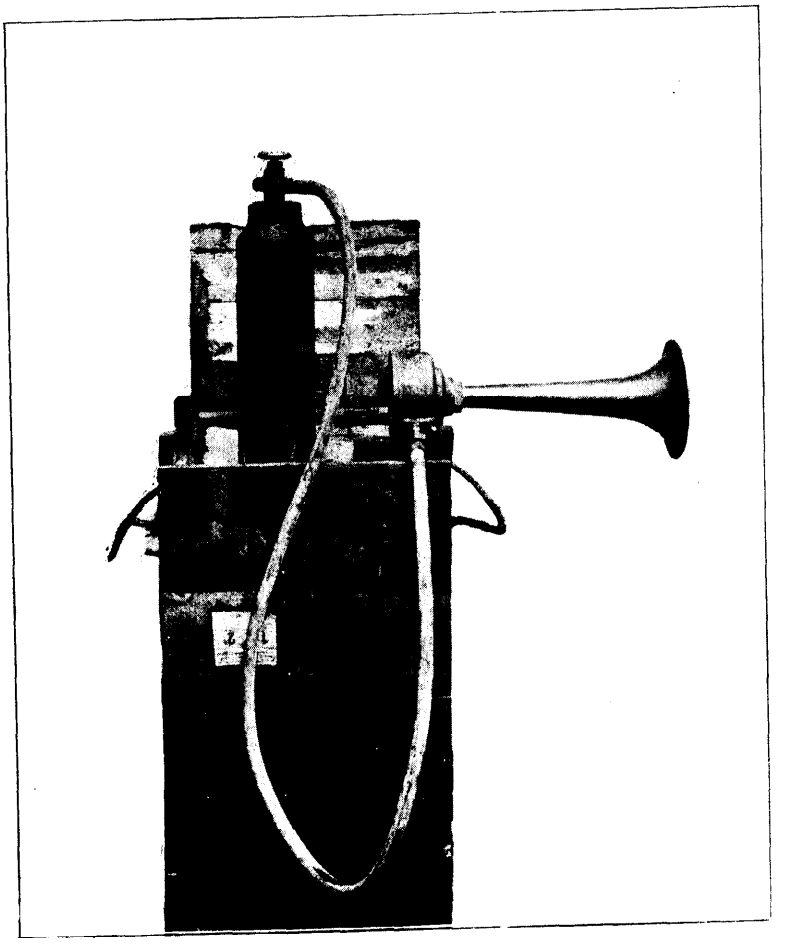

Fig. 17.

Strombos Horn

worked from the outside by the sentry responsible for warning the occupants.

67. CLOUD GAS ALARMS.—Experience in recent gas cloud attacks has shown that compressed air sirens like the Strombos horn are the most effective devices for conveying the alarm to troops in support and reserve lines and in billets behind the trenches. Strombos Horns are audible for very long distances and are intended for use only when it is certain that a cloud gas attack is being made.

68. The Strombos horn (see Fig. 17) is issued in a box containing one horn, two compressed-air cylinders, one length of rubber tubing with butterfly screw connections, one screwdriver and one gimlet. A third cylinder is issued with the horn, to be kept at the Divisional or Brigade Headquarters, to replace used cylinders without delay. An extra reserve of charged cylinders is also kept at the refilling stations.

69. Method of Use.—Strombos horns should be in the front line at intervals ordinarily not greater than 400 yards apart and at such other points behind the front, as required, to ensure transmission of warning. In back areas they should, if possible, be installed at places connected with the telephone, so that telephonic confirmation of the alarm may be obtained before the horn is sounded, thus avoiding the disturbance consequent on a false alarm.

70. The horn should be mounted in a horizontal position by screwing to the outside of the case or to some other suitable support, and must be protected as much as possible from rain or shell splinters. If possible, it should be so located that it has a clear field of sound to the rear and does not blow straight into the parados. Should it be necessary to change its position, the horn should be fixed in the box by means of the butterfly nuts provided. Strombos horns must always be ready for use, the horn being connected to one of the compressed-air cylinders by the rubber tube. The union joints at both ends of the tube must be tight.

71. TO SOUND THE HORN, UNSCREW THE SCREW CAP ON THE AIR CYLINDER TWO COMPLETE TURNS. The horn will sound for about one minute.

Immediately after use, couple up the horn to the second air cylinder and leave it ready for use in case of a second

gas cloud. The used cylinder should be clearly marked **EMPTY** and replaced as soon as possible from the reserve. Should it be necessary to use the second cylinder before the first one is replaced, the horn should be sounded for only 20 seconds at a time.

72. Replacement and Repair.—The pressure of the cylinders must be tested under arrangements made by the Divisional Gas Officer once every week and defective ones returned for recharging.

On no account is any adjustment of the horn to be attempted except by the Divisional Gas Officer or his trained Divisional Gas Non-Commissioned Officers. A horn may be thrown completely out of action by movement of any of its parts.

Damaged horns must be sent back immediately for repairs.

(B) PROTECTION OF SHELTERS AND DUGOUTS.

73. It is most desirable that dugouts should be rendered proof against gas if possible. Such protection is effected if all entrances are closed by well-fitting doors or by wet blankets or similar material. Doors and frames covered with blankets are generally unsatisfactory because of the wood warping and not providing a gas-tight joint.

Blankets moistened with water or with a dilute solution of glycerine allow very little gas to pass through and protection then depends on getting a good joint at the sides and bottom of a doorway, so as to stop all draughts. If two blankets are used with an air space between them, complete protection can be obtained.

74. The following methods of fitting blankets have been found to give good protection and to allow the entrance to be used during a gas attack:

METHOD I.—Two sloping frames made of 4-in. by 1-in. boards and covered with blanket material are fitted to the outside and inside of the entrance of a dugout at an angle of 15 degrees or 20 degrees with the vertical, as shown in Figs. 18 and 19. Blankets cut to the proper size are nailed to the top of the frames with a lath to prevent tearing. The blankets overlap the edge of the framework by two or three inches and hang with about nine inches resting on the ground.

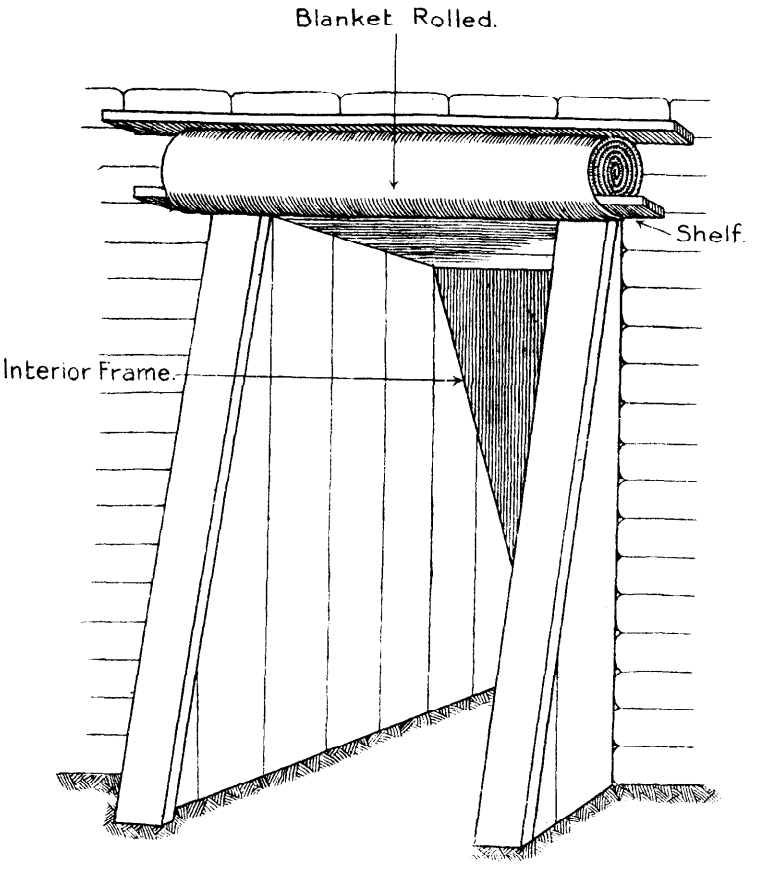

Fig. 18.

Protection of Dugouts.

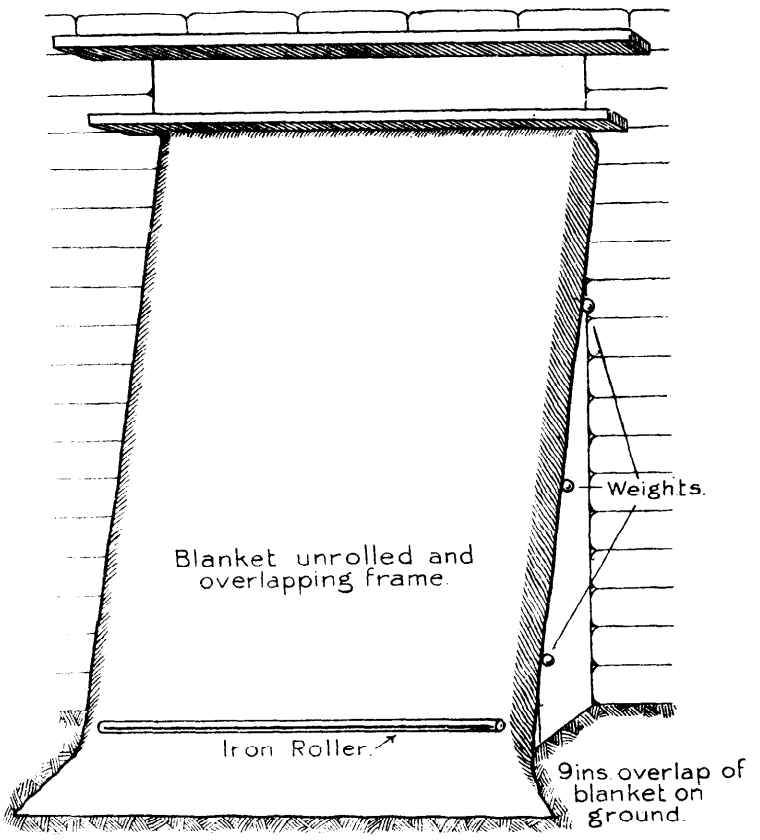

Fig. 19.

Protection of Dugouts.

Three small weights are tied to the side of the blanket, and a roller is fixed on the **outside** about three inches from the ground, so that the blanket hangs closely to the wooden frame. The blankets should be not less than two feet apart to allow a man to stand between them and adjust one before raising the other. The distance should be increased for Aid Posts and Dressing Stations to allow stretcher cases to be brought in.

When not in use the blankets should be rolled up and held so that they can be readily released.

75. METHOD II.—In many cases such a projecting framework cannot be fitted conveniently. In these circumstances a flat framework of 4-in. by 1-in. board, **covered with blanket material,** should be fastened flush with the wall, and the blanket curtain must be cut to reach the wall, and not to overlap the frame. It must be kept extended by three wooden laths. While the blanket is rolled up the bottom of the frame should be protected by a metal step (see Fig. 20). Figure 21 shows a similar arrangement on the stairway of a mine dugout. The blankets should be sprayed with water or with a dilute solution of glycerine (e. g., from a Vermorel sprayer, see Fig. 22). If they dry, they should be re-sprayed.

76. Everyone must be taught how to use gas-proof dug-outs—e. g., how to enter a protected doorway quickly, replacing the blanket immediately, and carrying in as little outside air as possible.

The protection afforded by these means is just as complete against lachrymatory and mustard gases as it is against cloud gas and poisonous shell gases.

SHELTERS WHICH SHOULD BE PROTECTED.

77. The following should always be protected:

Medical aid-posts and advanced dressing stations; Company, Regiment and Brigade Headquarters; at least one dug-out per battery position; Signal Shelters and any other place where work has to be carried out during a gas attack.

In addition to the above, it is desirable to protect all dugouts, cellars and buildings within the shell area, and this should be proceeded with as soon as the essential shelters mentioned above, have been fitted. It should be noted, however, that the protection of dugouts for troops in the front

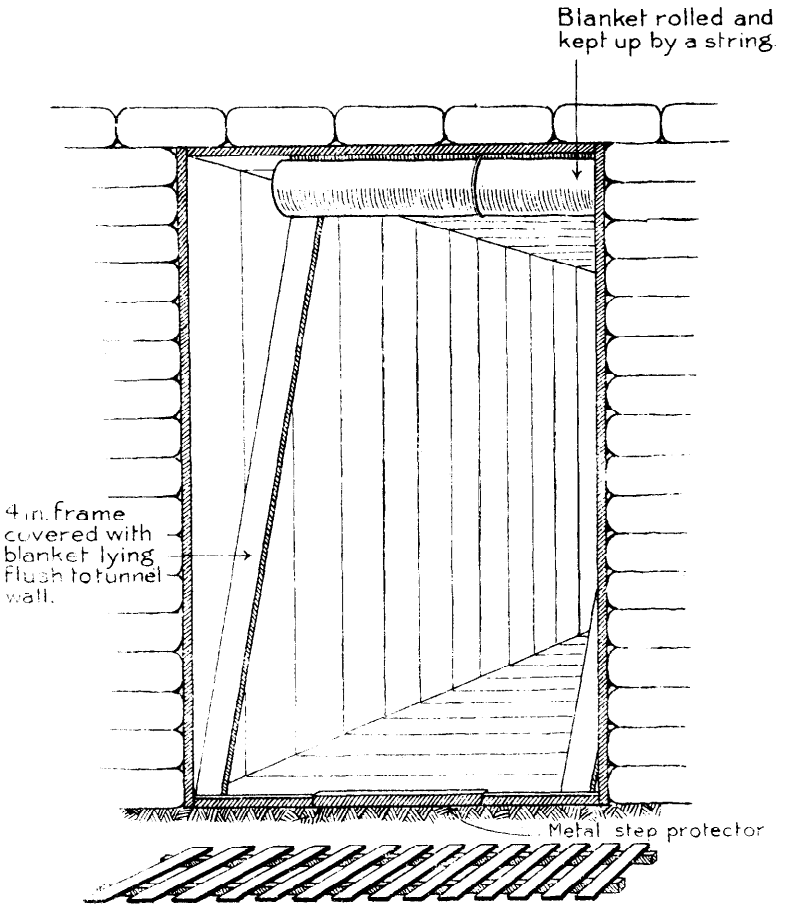

Fig. 20.

Protection of **Dugouts.**

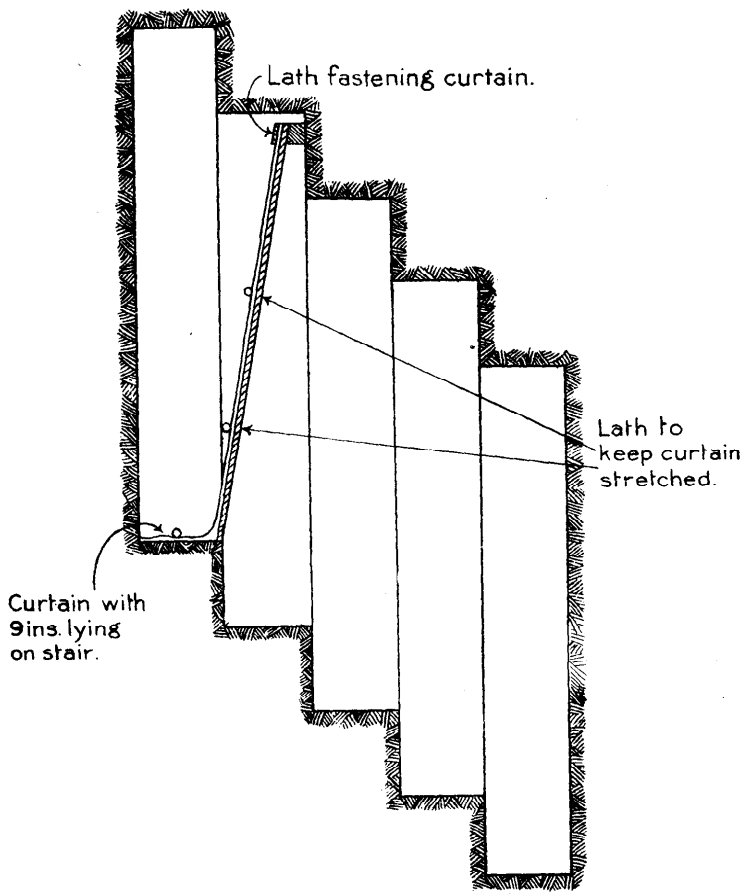

Fig. 21.

Protection of Dugouts.

Fig. 22.

Method of Keeping Blankets Moist.

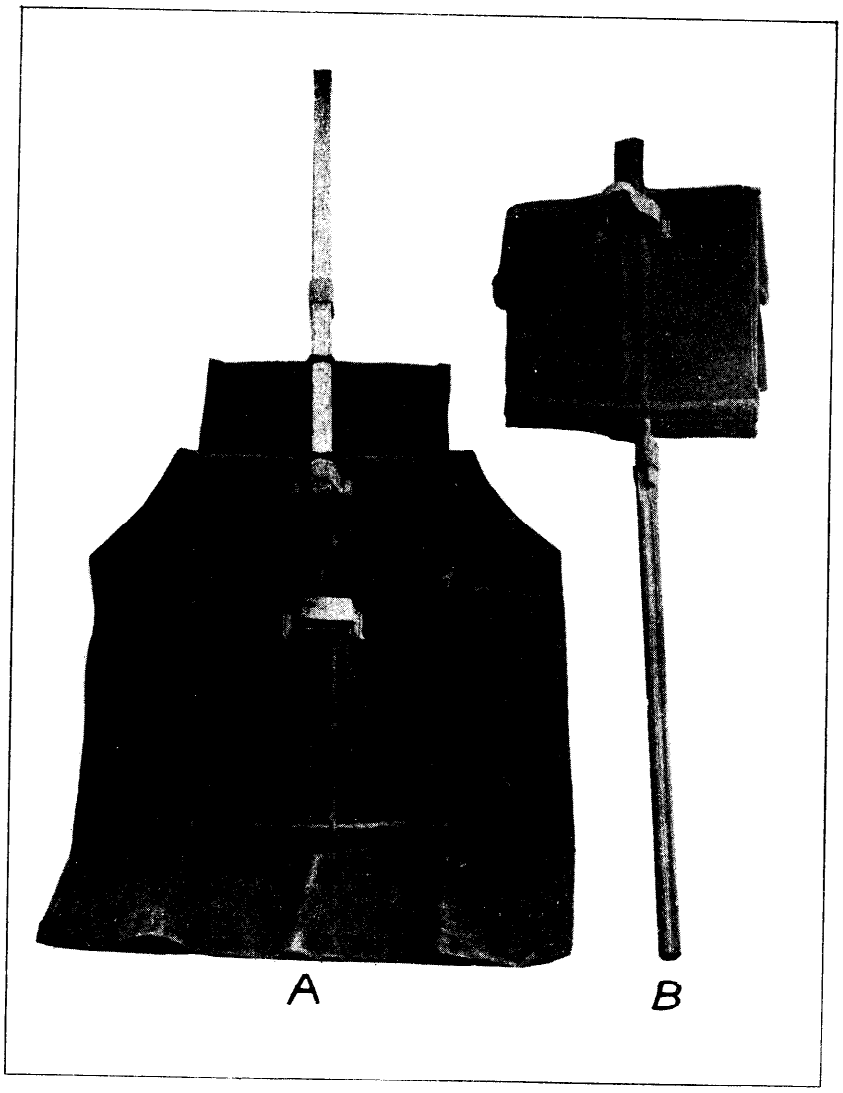

Fig. 23.

Trench Fans.

line of trenches is usually inadvisable on account of the delay involved in getting men out in time of attack. It is desirable to protect stretcher bearers' dugouts with a view to putting casualties in them.

78. VENTILATION OF DUGOUTS DURING A GAS ATTACK.—Pumps of various types have been suggested from time to time as a possible means of ventilating dugouts during a gas attack or clearing them subsequently. In the former case the intake of the pump is connected with a filter bed of earth by which chlorine, etc., is removed from the incoming air. The pumps may be operated by hand or by electric motors.

It is obvious that difficulties of transportation, installation and operation seriously limit the value of such devices, and up to the present, artificial ventilation has not been found necessary.

79. No standard method has been adopted by the Germans for the protection of dugouts, though important shelters are fitted with blankets or with a "Schutzsalzdecke"—a kind of quilt stuffed with peat moss and moistened with potassium carbonate solution.

(C) CLEARING GAS FROM TRENCHES AND DUGOUTS.

80. It is essential that no dugout be entered after a gas attack, except with respirators adjusted, until it has been ascertained that it is free from gas. Clearing gas from dugouts, etc., was previously done by spraying with hypo and soda solution.

81. The use of Vermorel sprayers for clearing gas has been given up. The hypo solution originally used against chlorine has very little effect on phosgene, and even with the addition of hexamethylene tetramine it cannot be relied upon to remove this gas from the air when present in appreciable quantity. Sprayers have consequently been withdrawn from general use and are now employed only for moistening the blankets of protected dugouts. The only efficient method of clearing shelters from gas is through ventilation.

82. An appreciable quantity of gas may be retained in the clothing of men exposed to gas attacks and also in bedding, coats, etc., left in shelters. Precautions should, therefore, be

taken to air all clothing.

83. NATURAL VENTILATION.—Unless a shelter has been thoroughly ventilated by artificial means, as described below, it must not be slept in or occupied without wearing respirators, until at least twelve hours have elapsed. It must not be entered at all without respirators on for at least three hours. The above refers to cloud gas attacks. In case of gas shell bombardments the times cannot be definitely stated, as they depend on the nature of the gas used and the severity of the bombardment. With mustard gas and with lachrymatory gases the time after which shelters can be used without discomfort may be considerably longer than those mentioned above.

84. VENTILATION BY FIRE.—All kinds of shelters can be efficiently and rapidly cleared of gas by the use of fires. Shelters with two openings are the easiest to ventilate, and where possible, dugouts with only one entrance should have a second opening made, even a very small one, to assist in ventilation.

In dugouts provided with a single exit at the end of a short passage the best results are obtained if the fire is placed in the center of the floor of the dugout and at a height of about 6 inches.

In dugouts provided with a single exit at the end of a long and nearly horizontal passage the best results are obtained if the fire is placed about one-third of the distance from the inner end of the passage.

In dugouts provided with two or more exits the fire should be placed at the inner end of one of the exit passages.

In general, one pound of dry wood per 100 cubic feet of air space is sufficient for clearance of any gas. The best fuel is split wood, but any fuel which does not smoulder or give off thick smoke can be used. The materials for the fire—e. g., the split wood, newspaper, and a small bottle of paraffin for lighting purposes—should be kept in a sandbag enclosed in a biscuit tin provided with a lid. An improvised brazier should be kept ready for use.

The fire must be kept burning for at least ten minutes and the atmosphere in the shelter should be tested from time to time.

85. VENTILATION BY FANNING.—Dugouts can be ventilated by producing air currents in them by means of

special anti-gas fans known as Canvas Trench Fans.

The fan consists of a sheet of canvas supported by braces of cane and reinforced in the middle. It is made with two transverse hinges and is fitted with a hickory handle. The flapping portion is roughly 15 inches square and the handle is 2 feet long. (See Fig. 23.) The fan folds up into a small space, as shown in B.

METHOD OF USING CANVAS TRENCH FANS.

86. (a) CLEARING TRENCHES.—The fan blade is placed on the ground with the brace side **downwards,** the man using it being in a slightly crouching position with the left foot advanced, the right hand grasping the handle at the neck and the left hand near the butt end. The fan is brought up quickly over the right shoulder, and then smartly flicked to the ground. This drives a current of air along the earth and, on the top strokes, throws the gas out of the trench. The part of the fan blade nearest the handle should touch the ground first, and this can be accomplished in all cases by ending the stroke with the whole length of the handle as close to the ground as possible.

87. In working round a traverse (Fig. 24), etc., the fan should be flapped round the corner with the hinge on the corner and the lower edge of the fan as near the bottom of the trench as can be managed. The brace side of the fan is to be outward, and at the end of the stroke the whole length of the handle should be close up to the side of the trench.

88. If several fans are available, men should work in a single file and with "out-of-step" strokes—i. e., one fan should be up while the next is down. (Fig. 25.) The alternative method shown in Fig. 26 may also be used.

89. (b) CLEARING SHELTERS.—In the case of a dug-out with a single entrance not exceeding 12 feet in length, the gas is first cleared from the neighborhood of the shelter as in par. 86 and then the corners worked round as in par 87. The worker now advances to the inner end of the entrance, beating rather slowly on the ground to allow the gas time to get out of the tunnel and bringing the fan as near the roof as possible on the return stroke.

90. If two men are available they should take up positions outside the entrance facing each other and slightly toward

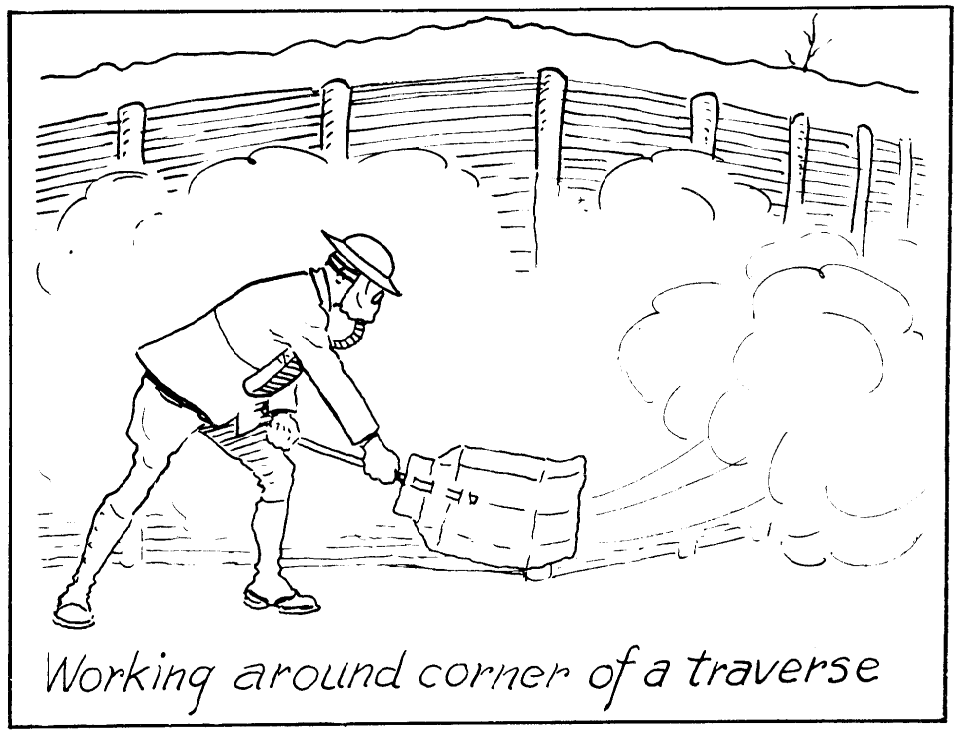

Fig. 24.

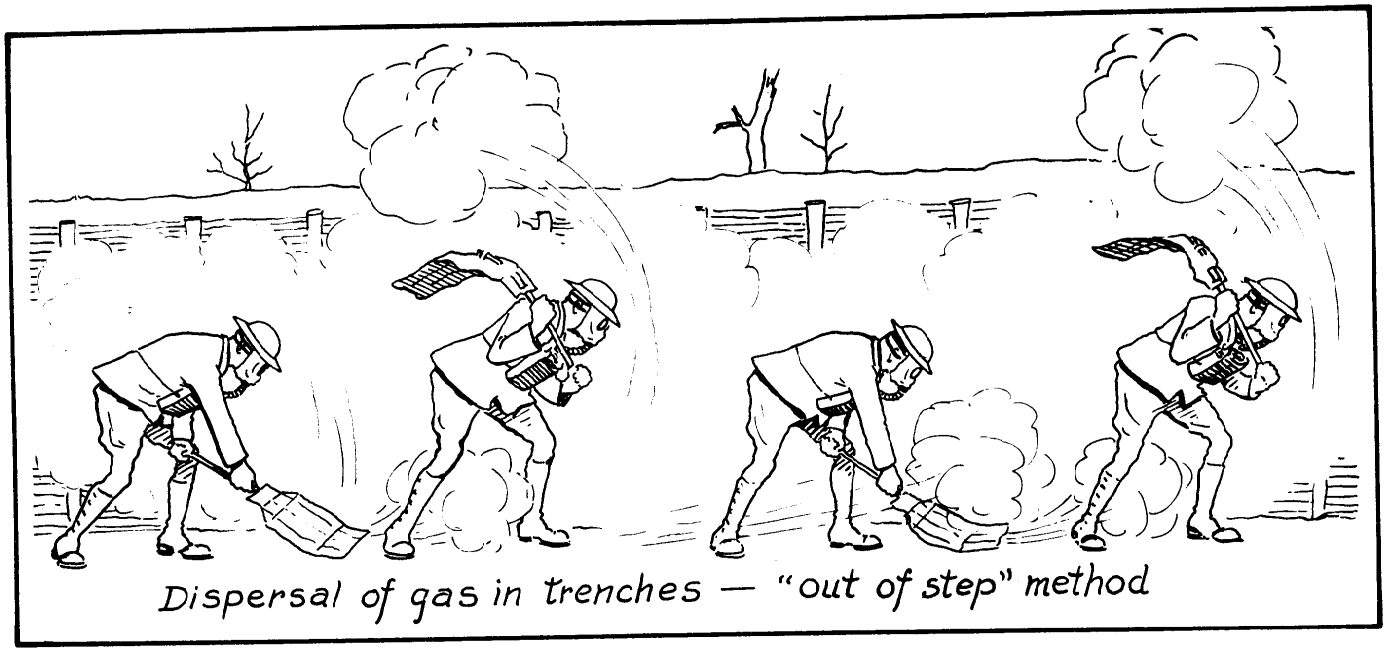

Fig. 25.

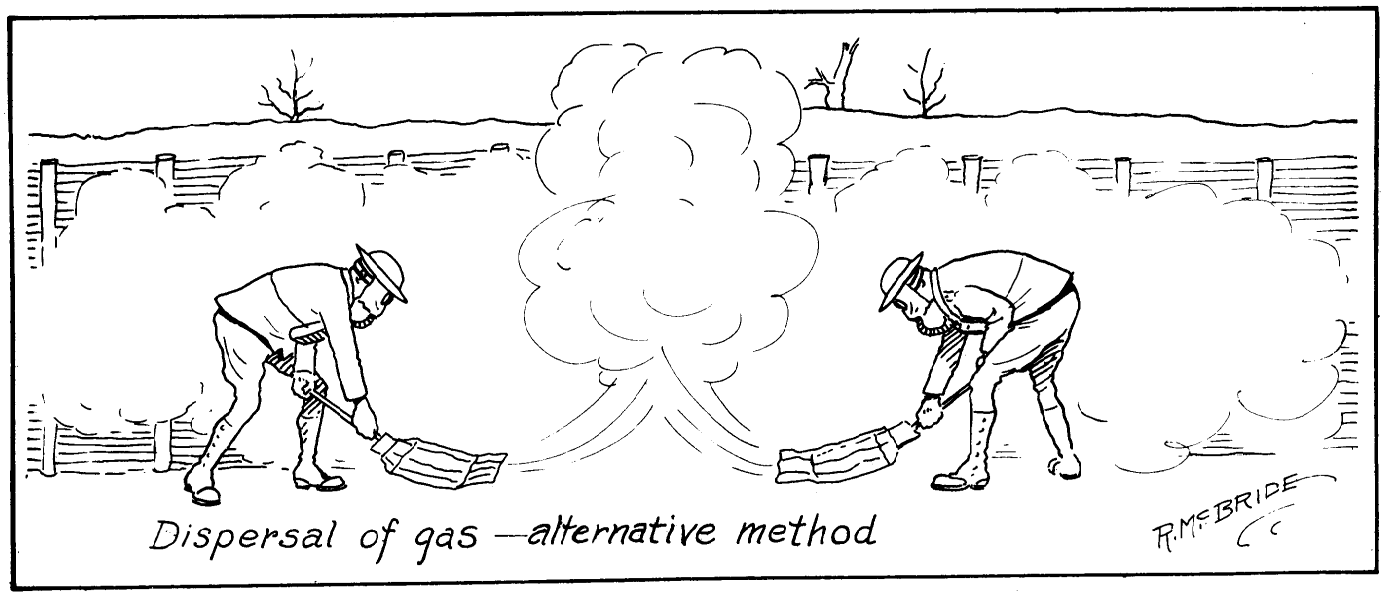

Fig. 26.

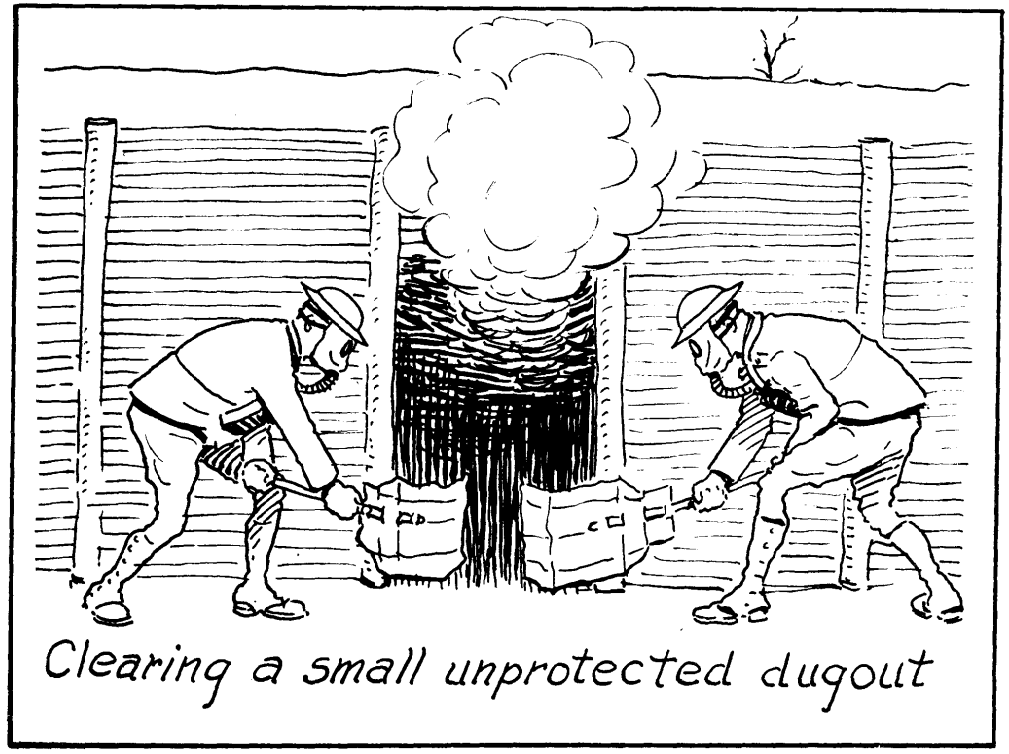

Fig. 27.

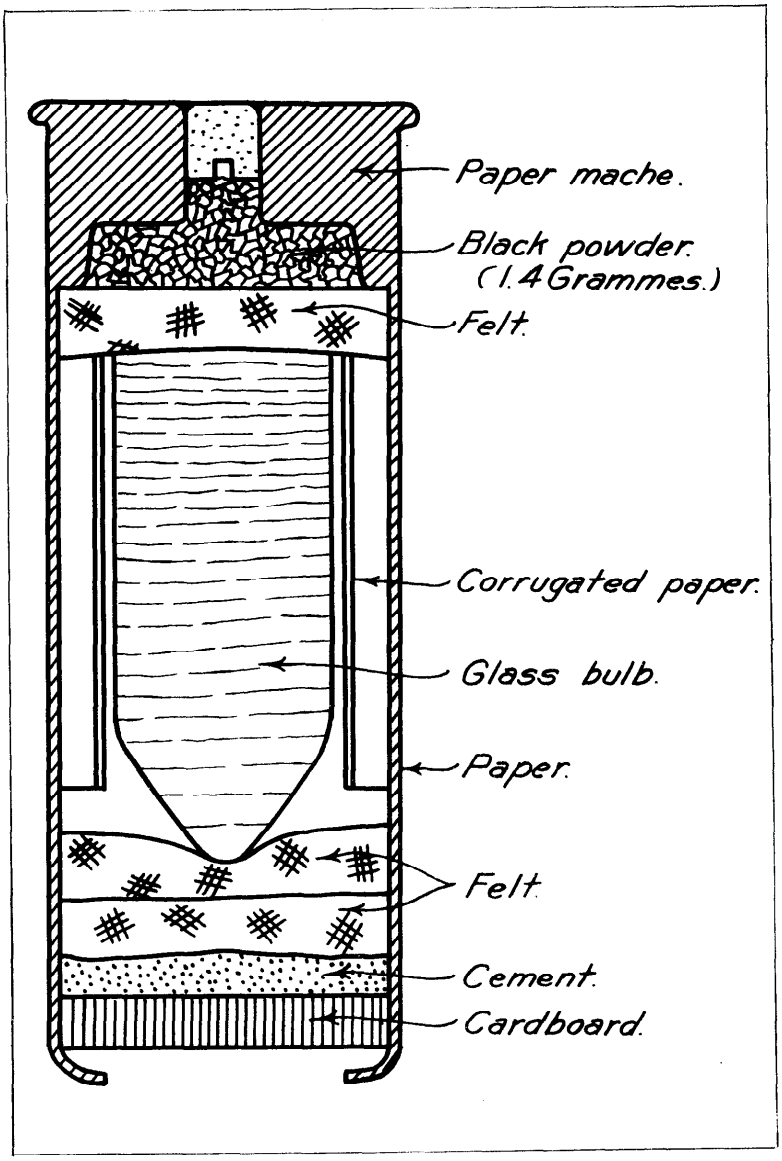

Fig. 27A.
German Deodorizing Cartridge

the entrance. They flap **alternately,** striking inward and slightly downward, as shown in Fig. 27. These movements force in a current of pure air at the bottom of the entrance, the gas being forced out at the top.

91. In the case of dugouts with two entrances or with one entrance and another opening, such as a chimney, it is only necessary to use the fan round the corner of one entrance in the manner described in par. 87. When the entrance is cleared, it is advisable to enter the shelter with a respirator on in order to beat up the gas from the floor boards, etc. This greatly facilitates the removal of the last traces of gas.

92. If no anti-gas fans are available, ventilation can be assisted by flapping with improvised fans such as sandbags, ponchos, etc.

93. GERMAN DEODORIZING CARTRIDGES.—In cases where it is impossible to clear gas quickly from dugouts by ventilation, the Germans make use of "deodorizing cartridges" (Entstänkerungspatrone), which are fired into the dugout from a flare pistol. These cartridges are of two kinds, marked E-I and E-II, and containing respectively 7 grams of dimethyl aniline and a mixture of dimethyl pyridines. For poison gas one of each type of cartridge is fired, but for lachrymators E-II only is used.

This method of clearing dugouts is rather unsatisfactory and the Germans do not place much reliance on it. The atmosphere left after explosion of the cartridges is still irritant and must be cleared by ventilation, but it is claimed by the Germans to be non-poisonous.

Fig. 27A shows a cartridge used for this purpose. These cartridges are also used with a glass bulb filled with lachrymator for the purpose of producing a lachrymatory atmosphere in chambers used to test the fit of respirators.

(D) PROTECTION OF WEAPONS AND EQUIPMENT.

94. Arms and ammunition and the metal parts of special equipment (e. g., telephone instruments) must be carefully protected against gas by greasing them or keeping them completely covered. Otherwise, particularly in damp weather, they may rust or corrode so badly as to refuse to act. A

mineral oil must be used for this purpose. The following in particular should be protected:

95. SMALL ARMS AND SMALL ARMS AMMUNITION.—Machine guns and rifles must be kept carefully cleaned and well oiled. The effects of corrosion of ammunition are of even more importance than the direct effects of gas upon machine guns and rifles.

Ammunition boxes must be kept closed. Vickers belts should be kept in their boxes until actually required for use. These belt boxes should be made gas-tight, if necessary by inserting strips of flannelette in the joint between the lid and the box.

Magazines for light machine guns should similarly be kept in some form of gas-tight box.

A recess should be made, high up in the parapet if possible, for storing ammunition and guns. A blanket curtain, kept moist, as in the case of blankets for dugouts, will greatly assist in keeping the gas out.

96. HAND AND RIFLE GRENADES.—Unboxed grenades should be kept covered as far as possible. All safety pins and working parts, especially those made of brass, should be kept oiled to prevent their setting from corrosion by the gas. The rods also require the same treatment.

97. LIGHT TRENCH MORTARS AND AMMUNITION.—As far as the supply of oil permits, the bore and all bright parts of light trench mortars and their spare parts should be kept permanently oiled. When not in use, mortars should be covered with sacking or similar material.

Unboxed ammunition should be kept covered as far as possible and the bright parts oiled immediately after arrival. Ammunition which has been in store for some time should be used up first.

98. GUNS AND AMMUNITION.—The following precautions apply to medium and heavy trench mortars as well as to guns and howitzers:

Batteries which are in constant danger of gas attacks, whether from gas clouds or gas shells, should keep all bright parts of the gun or mortar, carriage, mounting and accessories well coated with oil.

Sights and all instruments should also be smeared with oil and protected with covers when not in actual use, care being taken that the oil does not come in contact with any glass

or find its way into the interior of the instrument.

Cartridge cases of the ammunition stored with the Battery and all uncapped fuses, or fuses which have been removed from their cylinders, should be wiped over with oil as soon as possible and protected with a cover.

99. SIGNAL EQUIPMENT.—The only effective method of preventing corrosion of electrical apparatus during a gas attack is to prevent the gas reaching it and the best way of doing this is to have Signal Shelters and Offices thoroughly protected against gas. As the corrosive effect on damp instruments is very much greater than on dry instruments, the shelters should be kept as dry as possible.

During a gas attack telephones must be kept in their leather cases and unless the buzzer key is being used the leather flap must be kept down, leaving only the cords with receiver and hand-set out of the case. The backs of switchboards and buzzer exchanges must be kept closed. All apparatus, such as magneto telephones, test boards, spare instruments, etc., which it is not essential to have uncovered should be well covered up with cloths, blankets or coats, etc.

(E) PROTECTION OF ANIMALS.

HORSES.

100. Horses can stand a higher concentration of gas than human beings without material damage, and it is not necessary, therefore, to protect them against cloud gas attacks at long distances from the trenches. Nor is it necessary to protect their eyes.

101. HORSE RESPIRATORS.—Horse respirators should primarily be supplied for transport animals and for artillery horses when they are sent to the vicinity of the trenches or to areas liable to heavy gas shell bombardment.

102. The American Horse Respirator, which is similar to the British, consists of a flannelette bag with a canvas mouthpiece which goes into the horse's mouth and saves the flannelette from being bitten through. The bag is provided with an elastic band which passes round the opening so as to draw the respirator close to the face when in use. The

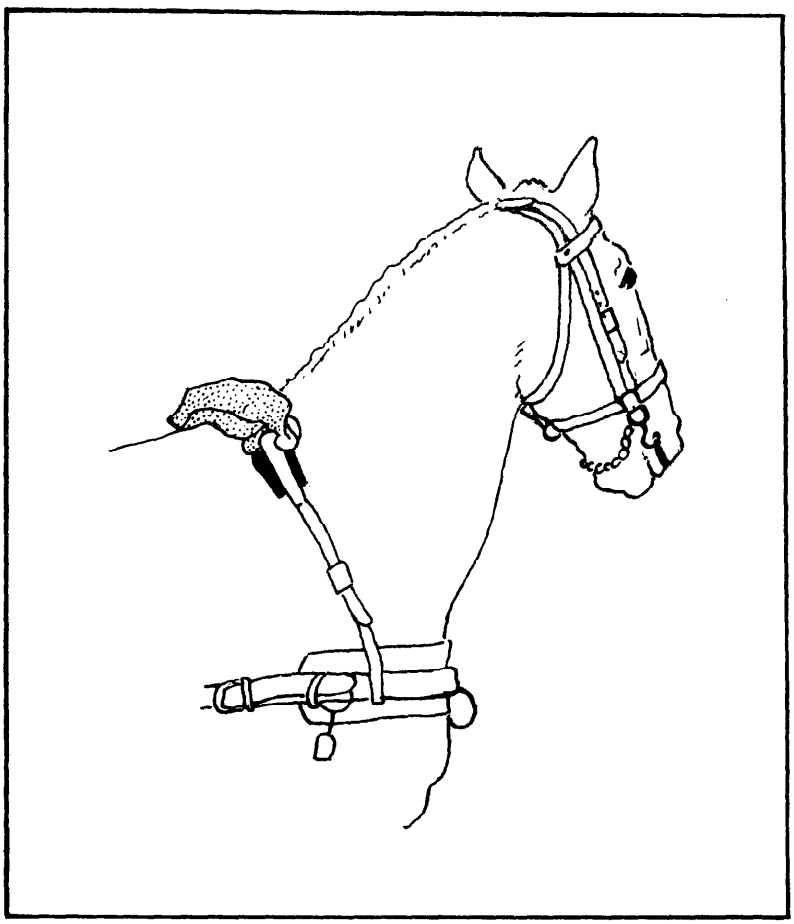

Fig. 28.

Horse Mask in the "Carry" Position.

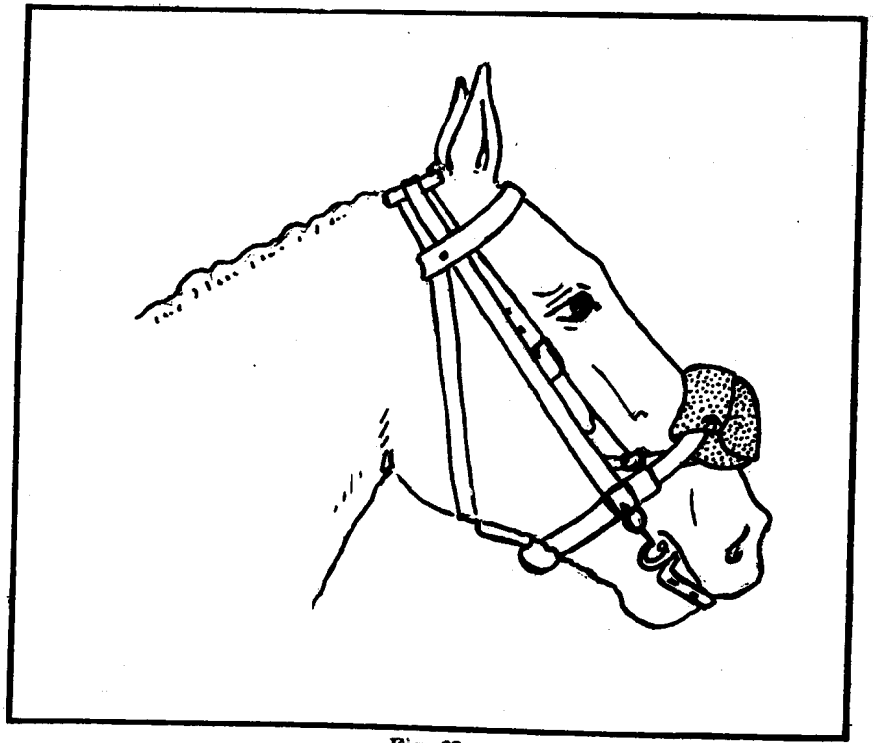

Fig. 29.
Horse Mask in the "Alert" Position.

upper side of the mouth of the flannelette bag is furnished with a small unbleached calico patch by which the respirator is attached to the nose band of the head collar when in the "alert" position, and while in use. Inside the bag and attached to the canvas mouthpiece there is a canvas frame which is stitched on the bag in such a way as to prevent the material drawing into the nostrils when the respirator is in use. The whole is folded and carried in a canvas case provided with a flap, secured by three snap fasteners, and having two straps at the back by which the case is attached to the head collar.

103. CARRYING WHEN NOT IMMEDIATELY REQUIRED.—When not required for immediate use the respirator can be conveniently carried on the breast band or on the supporting strap of the breast band, as shown in Fig. 28. However carried, the case is steadied by being strapped on either side to the metal ring on the supporting strap, and its flap should be passed under this strap, between it and the wither pad, and buttoned as in the "alert" position.

104. ALERT POSITION.—When horses are being sent up to the trenches, the transport or other officer responsible should have the respirators adjusted in the "alert" position before moving off, as follows:

(a) The flap of the respirator case is unbuttoned and slipped under the nose-band of the head collar from below upward.

(b) The two straps at the back are also passed under the nose band and secured to the cheek pieces of the head collar, above the metal D on each side.

(c) The small unbleached calico patch on the upper side of the mouth of the respirator is buttoned on to the nose-band of the head collar so that the respirator is ready to be slipped on immediately in the event of a gas attack.

(d) The cover of the case is then closed over the nose-band, and the respirator is thus protected from rain, etc., and held in position on the nose-band. Fig. 29 shows a respirator in its case carried in the "alert" position.

In cases where the horse is galled by wearing the respirator in the "alert" position, as above, it may be advisable

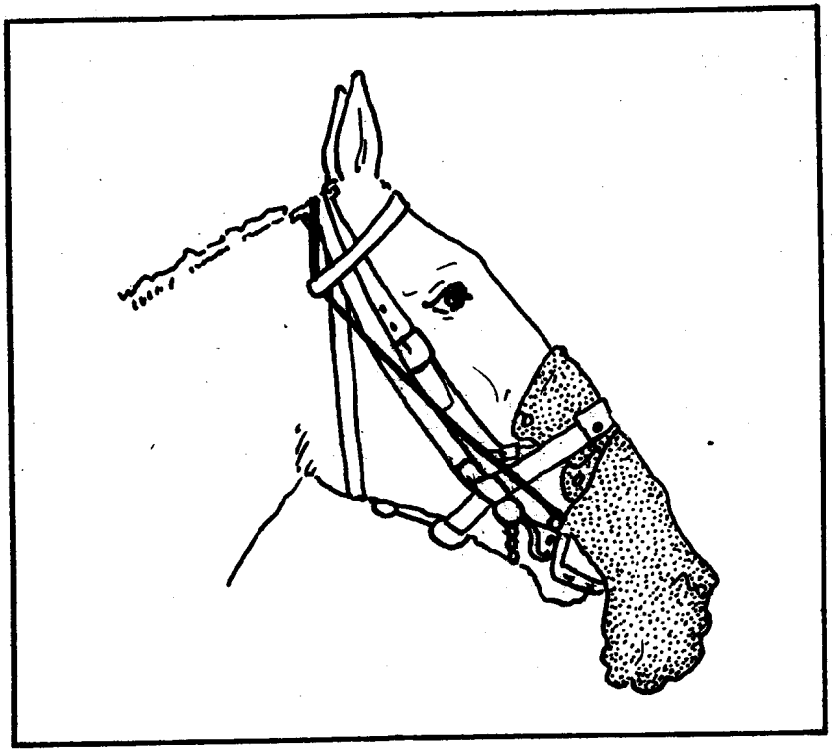

Fig. 30.
In the Gas Area.

Fig. 31.
German Box for Protecting Carrier Pigeons from Gas

to continue carrying it attached to the breast band. It must then be completely adjusted from this position for wearing in gas, as in par. 105.

105. WEARING IN GAS.—The respirator being carried in the "alert" position is adjusted for use as follows:

(a) The flap of the case is unbuttoned and the respirator removed, leaving the case attached to the cheek pieces of the head collar and lying flat on the face.

(b) The mouth of the bag is drawn down over the lip and upper teeth with one hand on each side of the mouthpiece, slipped into the mouth, and drawn well up to the angle of the lips.

(c) The elastic band is seized on either side close to the mouthpiece and pulled outward so as to draw the mouth of the bag tight around the upper jaw, above the nostrils, and is then slipped over the poll.

The respirator is then in position and the animal may be worked in it without difficulty or undue distress. The bit and reins are not interfered with in any way. (This is shown in Fig. 30.)

106. REPLACEMENT IN CASE.—In folding the respirator and placing it in the case ready for use the following points should be observed:

(a) The canvas mouthpiece should be wiped as clean as possible.

(b) The flannelette bag should be held with the canvas mouthpiece underneath and the elastic band placed over the top of the bag in such a way that when the canvas patch is buttoned on to the nose-band the elastic band has simply to be passed straight up over the face and over the poll. The bottom end of the respirator should then be tucked in and rolled up over the elastic band to make a neat roll for insertion in the canvas case.

107. GERMAN HORSE RESPIRATOR.—The form of horse respirator adopted by the Germans is a much cruder form of appliance and consists of a double nose bag stuffed with rags, etc., which is dipped into water before being drawn over the horse's nose. When respirators are not available it is recommended that an ordinary nose bag filled with wet grass or straw be pulled over the horse's head.

As far as possible the Germans remove their horses from

the Gas Zone. Those in stables are protected by making the stable doors gastight (with dung, wet cloths, etc.).

CARRIER PIGEONS.

108. British Method.—Special gasproof covers made of flannelette are provided for drawing over pigeon baskets. These bags are soaked in chemicals and are fastened by means of pull-tapes.

When the gas alarm is sounded, all baskets containing pigeons are placed in the special anti-gas bags or removed to gasproof shelters. If for any reason the birds cannot be protected from the gas, they are liberated at once. Anti-gas bags should always be kept near baskets containing birds, and should be regularly inspected.

109. Pigeons can be utilized during a gas attack. Experience has proved that they will fly through any gas cloud, but it is imperative that the bird should be exposed to the gas for as short a time as possible. The message and its carrier should, therefore, be prepared and if possible fastened to the pigeon's leg before the bird is exposed to the gas. Twenty seconds should suffice to attach a carrier and liberate a bird.

110. German Method.—Special boxes are provided for carrier pigeons in which the ventilation is provided by holes at either end into which canisters similar to those used in the German respirator can be screwed. (Fig. 31.) In the event of a gas attack all that is needed is to screw a canister into either end of the box, which is thus rendered gas-proof.

(F) GAS DETECTORS AND SAMPLING DEVICES.

111. Detection of Gas.—Many types of apparatus have been devised and suggested for detecting poison gas in the atmosphere. Such devices are of two types:

(a) Those for detecting in advance a hostile gas cloud, so as to give quicker and automatic warning of its approach.

(b) Those intended for detecting gas in trenches and dugouts in order to determine when respirators must be put on or may be taken off.

112. Apparatus of the former type must be placed in "No Man's Land" as near the enemy trenches as possible. No such device has been adopted for use, chiefly owing

(a) To the danger of depending on an automatic device which may be destroyed or put out of order or may be tampered with by the enemy.

(b) To the fact that a really sensitive instrument requires frequent expert inspection which it is almost impossible to give under active service conditions.

113. Devices of the second type have also not been adopted chiefly owing to the difficulty of obtaining sufficiently sensitive detection of the most dangerous gases. The degree of sensitiveness of a gas detector must be such that it will show conclusively the presence of concentrations of gas which will be dangerous even only after long exposure. If it does not do this, or if it is liable to deteriorate or get out of order it acts as a trap to men depending on it and may induce them for example to remove their respirators too soon.

Up to the present time the most sensitive and safest method for detecting small quantities of gas is smell. This can be done without danger by any careful man who has attended a gas school.

114. Sampling Apparatus.—For the purpose of obtaining information as to the nature and concentration of the enemy gas used in attacks it is very desirable that samples be obtained.

In the case of gas shells, knowledge of the nature of the gas is generally readily obtainable from examination of blind shells, earth from shell holes, etc., but in the case of gas clouds, actual samples should be obtained. For this purpose two kinds of appliances are kept in the trenches, viz.: Vacuum bulbs and gas-testing tubes. These should be looked after by the Company Gas Non-Commissioned Officers, whose duty it is to take the samples, but officers should take all possible steps to ensure that samples of the gas are actually taken, as the information obtained may be of the greatest importance.

115. Method of Use.—The vacuum bulbs provided for taking samples of hostile cloud gases are strong glass vessels of the general shape shown in Fig. 32b. The capacity is usually about one litre. The air in these bulbs has been removed by means of a pump. One end of the bulb is drawn out to a point, and the glass here is so thin that on scratching it with a file the point is easily broken off. The air will

then rush in and fill the vessel and if it has been opened in a gas cloud attack it is obvious that a sample of the noxious gas will be obtained. The bulb can then be sealed and sent to a chemical laboratory for identification of the contents.

Samples of gas should be taken both in the fire and support trenches. The first sample should be taken about **two** minutes after the commencement of the attack and other samples at intervals during the attack.

The exact time and place should be noted on the form on the back of the box immediately after the sample is taken.

If, when the gas waves have passed, any bulbs remain unused, samples of air in unprotected dugouts should be taken before the latter are cleared.

Immediately after the vacuum bulbs have been used they should be taken under shelter.

116. Phosgene Detectors.—Various types of apparatus have been in use for detecting and estimating the concentration of phosgene in cloud and shell gas attacks. Most of these depend on the reaction between the phosgene and aniline water, which produce characteristic crystals of diphenyl urea. Others have been reactions showing a color change on specially prepared paper. In any case it is generally necessary first of all to remove any chlorine which may be present.

One such type of apparatus, as formerly used in the British Army, is shown in Fig. 32a.

After pulling out the small glass stopper air is pumped through the apparatus by squeezing the rubber bulb in the hand for ten minutes. If the number of times the bulb is squeezed is counted and recorded, useful information may be obtained by examination of the chemicals in the lower part of the tube. After the sample has been taken, the small glass stopper is replaced and the lid of the box put on **at once**, care being taken to avoid compressing the rubber bulb. On the label is noted the time and place at which the sample was taken.

V. ORGANIZATION OF GAS DEFENSE.

117. Officers are held responsible that all anti-gas appliances for protecting their men are maintained in perfect con-

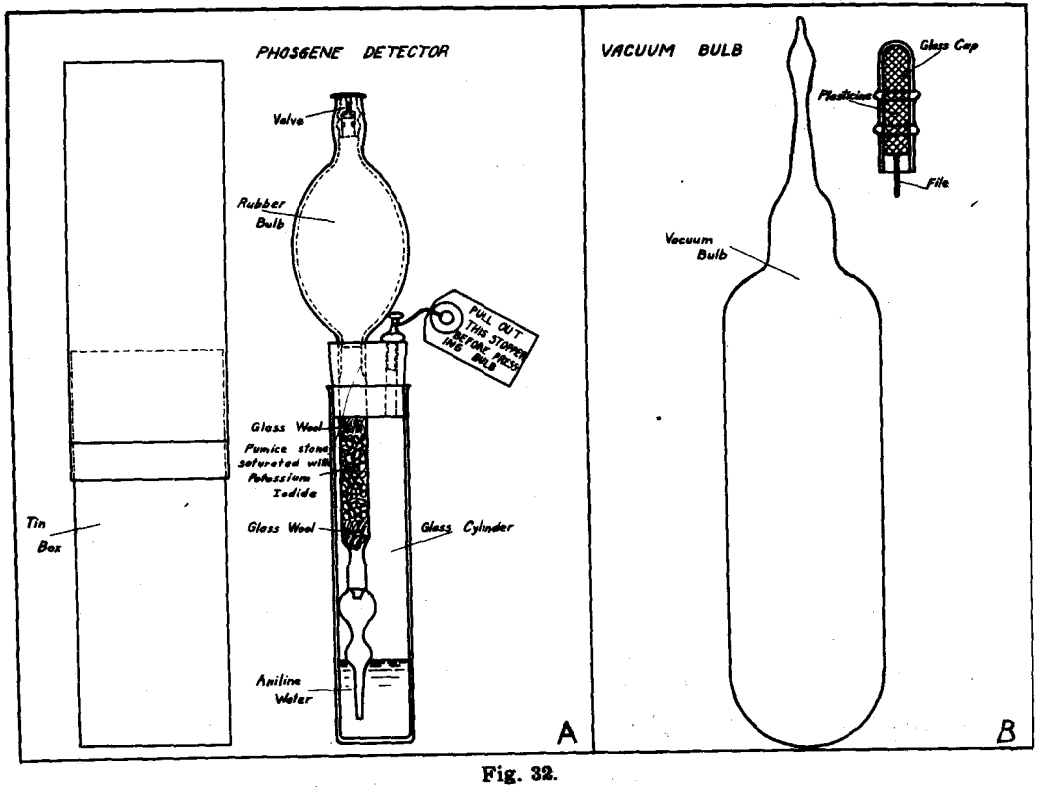
PHOSGENE DETECTOR
Valve
Rubber Bulb
PULL OUT THIS STOPPER BEFORE PRESSING BULB
Glass Wool
Pumice stone saturated with Potassium Iodide
Glass Wool
Glass Cylinder
Tin Box
Aniline Water
A
VACUUM BULB
Glass Cap
Plasticine
File
Vacuum Bulb
B

Fig. 32.

dition, and that everyone under their command is thoroughly trained in the use of these appliances and in all other measures which may affect his safety against gas.

118. The protective measures may be summarized as follows:

(a) Provision to each man of individual protective devices.
(b) Inspection of these appliances, training in their use and instruction in all other measures of gas defense.
(c) Provision of gas-proof shelters and dugouts.
(d) Weather observations to determine periods when the conditions are favorable to a hostile gas attack.
(e) Arrangement of signals and messages for immediate warning of a gas attack.
(f) Provision of appliances for clearing gas from trenches and shelters.

(A) ORGANIZATION OF ANTI-GAS DUTIES.

119. Everyone must be fully conversant with the measures to be adopted for defense against gas attacks as laid down in the existing orders of his formation or unit.*

120. **Specialist Officers.**—In order to provide efficient supervision of gas defense training, inspection of appliances, etc., and to provide readily available technical advice on all matters connected with gas defense, specialist officers are attached to headquarters of Corps, Divisions, etc.

The organization is practically identical in all the belligerent armies and allows for a Staff Officer (or an Officer attached to the Staff) at the Headquarters of Army, Corps and Division and for the appointment in each Regiment of a Regimental Gas Officer to be detailed by the Commanding Officer.

121. In the American and British armies, Gas Defense Schools are formed at Corps Headquarters for the purpose of training Officers and Non-Commissioned Officers in all defensive measures against gas attacks. (For training purposes in America a Gas Defense School is attached to each Division and is in charge of the Divisional Gas Officer.)

* For Standing Orders of American Expeditionary Force see Appendix [illegible]

Nothing in the above organization, however, absolves officers in any way from the responsibility as laid down in paragraph 117.

(B) ANTI-GAS DUTIES WITHIN AN INFANTRY REGIMENT.

(To be modified for other units to suit their organization and duties.)

122. The Commanding Officer will be directly responsible for all measures against gas attacks, and will be assisted by the Regimental Gas Officer. Battalion and Company Commanders will be responsible to the Commanding Officer for all anti-gas measures within their battalions and companies.

123. In each Company one Non-Commissioned Officer, who has been trained at an Anti-Gas School, and who has been recommended as suitable for duty as "Company Gas Non-Commissioned Officer," will be specially detailed to assist the Company Commander in anti-gas measures. At least one other similarly trained and recommended Non-Commissioned Officer will be immediately available to take the place of the Gas Non-Commissioned Officer in case of need.

A similarly trained Non-Commissioned Officer will be detailed to Regimental Headquarters for duty with Headquarter details.

124. The special duties of Gas Non-Commissioned Officers will be defined explicitly. **No other duties will be performed that interfere with the gas duties laid down.**

125. The selected Non-Commissioned Officers who attend the Gas Defense Schools will be reported on as follows: At the end of the course the Commandant of the School will, if the Non-Commissioned Officer is, in his opinion, suitable for duty as "Company Gas Non-Commissioned Officer," notify the Commanding Officer to this effect. The latter will then cause the words "Passed Gas Defense School" to be entered in his service record. Only Non-Commissioned Officers who have been reported on favorably will be detailed for duty as Company Gas Non-Commissioned Officers.

126. Commanding Officers must facilitate in every way the duties of the Divisional Gas Officer and his Non-Commissioned Officers in visiting their lines and inspecting anti-gas

arrangements, testing Strombos horn cylinders, etc. They should take every opportunity of consulting with the Divisional Gas Officer on all technical questions relating to anti-gas measures within their lines.

VI. ACTION BEFORE, DURING AND AFTER A GAS ATTACK.

(A) BEFORE AN ATTACK.

127. Carriage of Respirators.—(a) Between **five** and **twelve** miles from the front line (the "Precautionary Zone") respirators or masks must always be carried. This is necessitated by the far-reaching effect of gas cloud attacks.

(b) Within **five** miles of the front line the box respirator must always be carried. Between **five** and **two** miles from the front line (the "Ready Zone") respirators may be carried in the slung position, but nothing should be worn to interfere with the immediate shifting of the respirator to the alert position. To make sure that the mask fits properly, every man while in this region should be clean shaven (except that a mustache may be worn).

(c) Within **two** miles of the front line (the "Alert Zone") and in areas exposed to gas shelling, the respirator must be worn in the "alert" position. In order that nothing shall interfere with quick adjustment, it must be worn outside all clothing, and nothing should be slung across the chest. The chin strap of the steel helmet should be worn on the point of the chin.

128. General Precautionary Measures.—The following action should be taken within the two mile limit:

(a) Respirators must be inspected daily.

(b) Daily inspection of all gas alarm appliances and other gas defense stores must be carried out. The entrances to gas-proof dugouts must be kept in good order and the blankets kept moist.

(c) It is a part of the duty of all sentries to act as gas sentries. They should consequently be provided with alarm appliances, to give warning of gas shell or gas cloud attacks. All sentries must be instructed in the method of using the Strombos horn.

(d) Each sentry group should be assigned a definite area to alarm in the event of a gas attack or bombardment by gas shells.

(e) Special sentries must be posted to give warning to men in dugouts.

(f) All working parties of ten or more men must have a sentry posted to give warning in the event of gas attacks.

(g) Precautionary measures must be taken to protect ammunition from the corrosive action of the gas.

(h) Stores of fuel must be kept available for clearing dugouts.

(i) Wind observations must be made by units in the line and sentries warned to be specially on the alert for signs of cloud gas whenever the wind is in a dangerous quarter.

129. In the area between two and twelve miles from the front the following precautions must be observed:

(a) All gas defense appliances must be inspected at least once a week.

(b) All sentries, traffic control men, military police, etc., when on duty must act as gas sentries and when considered necessary should be provided with suitable alarm devices.

(c) Men may be allowed to take off their respirators when sleeping, but they must keep them within reach.

(d) Arrangements must be made by Commanders of units and area Commandants to communicate a gas alarm to everyone in the danger zone.

130. Special Precautionary Measures.—(a) **For Artillery.**—Aiming points and aiming posts are likely to be obscured by gas clouds or smoke, and arrangements should therefore be made in every Battery to meet this eventuality by providing gunpits with means to check the line of fire if necessary, without depending on the use of aiming posts.

(b) **For Tunneling Companies.**—Tunneling companies are reminded that the respirator does not afford protection against mine or explosion gases.

Owing to the difficulty in clearing gas, especially lachrymatory gas, from mine-shafts and galleries, the entrances to mine-shafts should be protected from gas by blanket curtains

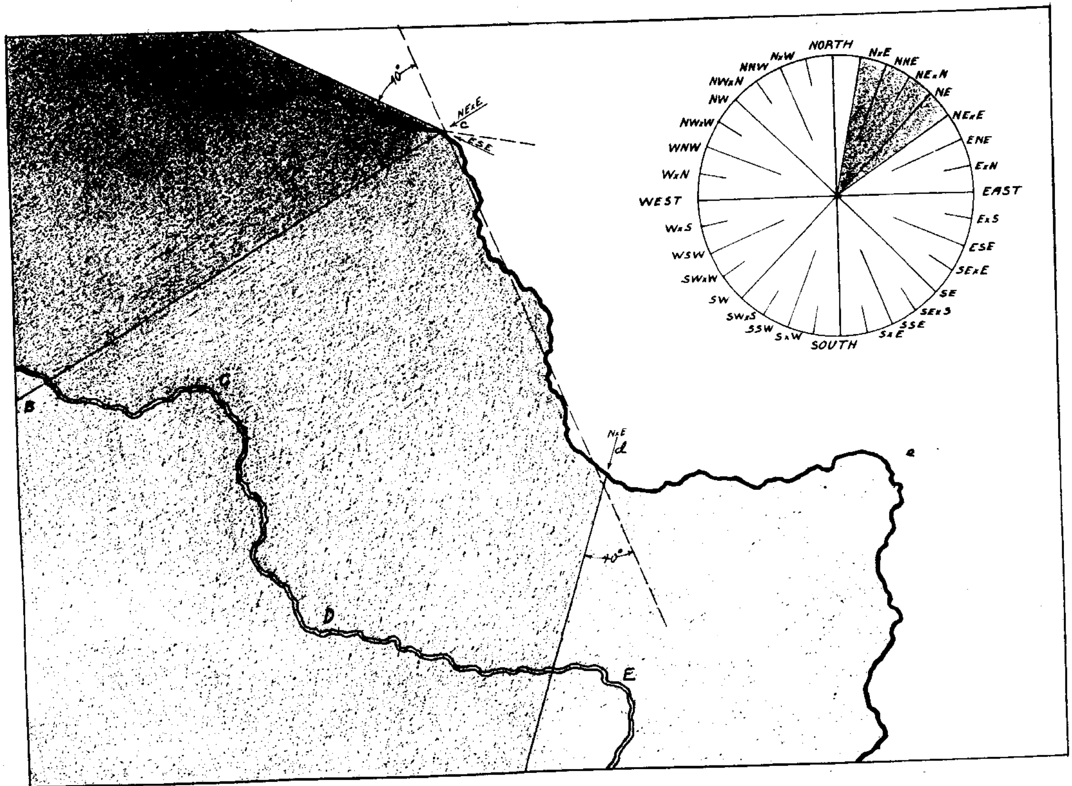
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Fig. 33.

in the manner already described for dugouts.

The enemy has occasionally attempted to render galleries untenable by the use of lachrymatory bombs in conjunction with the explosion of a charge. If this is done, the respirator must be worn if work has to be continued.

WIND OBSERVATIONS FOR CLOUD GAS ATTACKS

131. Dangerous Quarter for Winds.—On all stretches of enemy front there are only certain directions of wind which can be used for making cloud gas attacks. If the enemy trenches ran in a straight line from north to south, for example, a wind that blew north by east would be very likely to gas his own trenches, owing to slight changes in the wind and diffusion of gas cloud. There is therefore a factor of safety by which he must be governed. In the case just mentioned it would probably be an angle of 45 degrees with the general line of his own trenches. He would therefore only use winds blowing from NE to SE to make a gas attack.

132. The limits of wind direction are therefore governed by the general direction of the enemy's line and the "factor of safety" which he is willing to adopt. For isolated stretches of front this is probably 45 degrees to the line of trenches, but it must be remembered that the enemy may be willing to take greater risks than this or to evacuate for the time certain portions of his line which might come within the gassed area. In Fig. 33, which shows a section of trenches (enemy line shown in black), the margin of safety chosen is an angle of 40 degrees with the trench line, but it may be taken even lower than this.

133. If gas were to be liberated from the Section c-d, the margin of safety for this section would be represented by the entire shaded area. This includes winds between NxE and ESE. However, a wind blowing ESE would gas the section c-b. The margin of safety for c-b must therefore be considered. This restricts the available winds to those between NxE and NExE. Therefore the dangerous wind for an attack from the enemy section c-d is one which lies between these limits. It is represented on the map by the dark shaded area. The same section c-d is shown in Fig. 34. With the wind from NxE the enemy would gas his own trenches at and below i. If necessary for tactical reasons to make a

gas attack under such conditions, these trenches could be warned in order that the men might put on masks, or they might also be temporarily evacuated.

134. In the larger map the dangerous winds for each section (assuming an angle of 40 degrees is taken) are shown by shading the interval between the limits on the compass in each case. For example, in section b-c winds between NxE and NExE may be used for a gas attack, but no others. In the sections d-e, e-f and g-h, the margin is even narrower.

135. Wind Charts.—In order to allow for the above mentioned risks and not to have too many different angles of wind for the front occupied by our own troops it is customary to cover all dangerous directions of wind in one wind chart for each Division or Corps.

This allows not only for the variations of wind, as observed over large tracts, but also on isolated lengths of front where conditions of terrain or the alignment of the trenches may permit of local air currents which are favorable to the enemy. Wind charts built up on these lines for particular Corps and Divisional fronts should be prepared and issued to all units, so that sentries can be warned to be specially on the alert for signs of cloud gas attacks whenever the wind is in a dangerous quarter.

A typical wind chart used for this purpose is shown in Fig. 35, which represents the dangerous winds for all sections of trench shown on the wind map in Fig. 34.

136. Meteorological Reports.—The direction and strength of the wind, together with forecasts for the next twenty-four hours, are sent daily by the Meteorological Service to headquarters of formations. These reports are general, however, and refer to large tracts of country. They are to be used in conjunction with local observations, but never replace them.

137. Local Observations.—It is possible that on isolated lengths of front air currents may occur which are favorable to the enemy. It is essential therefore that the troops themselves should be on the lookout for the possibility of a cloud gas attack. For this purpose Company Commanders are responsible that wind observations are made on their company front every three hours, or oftener if the wind is in or approaching a dangerous quarter, and the reports forwarded to the proper authorities.

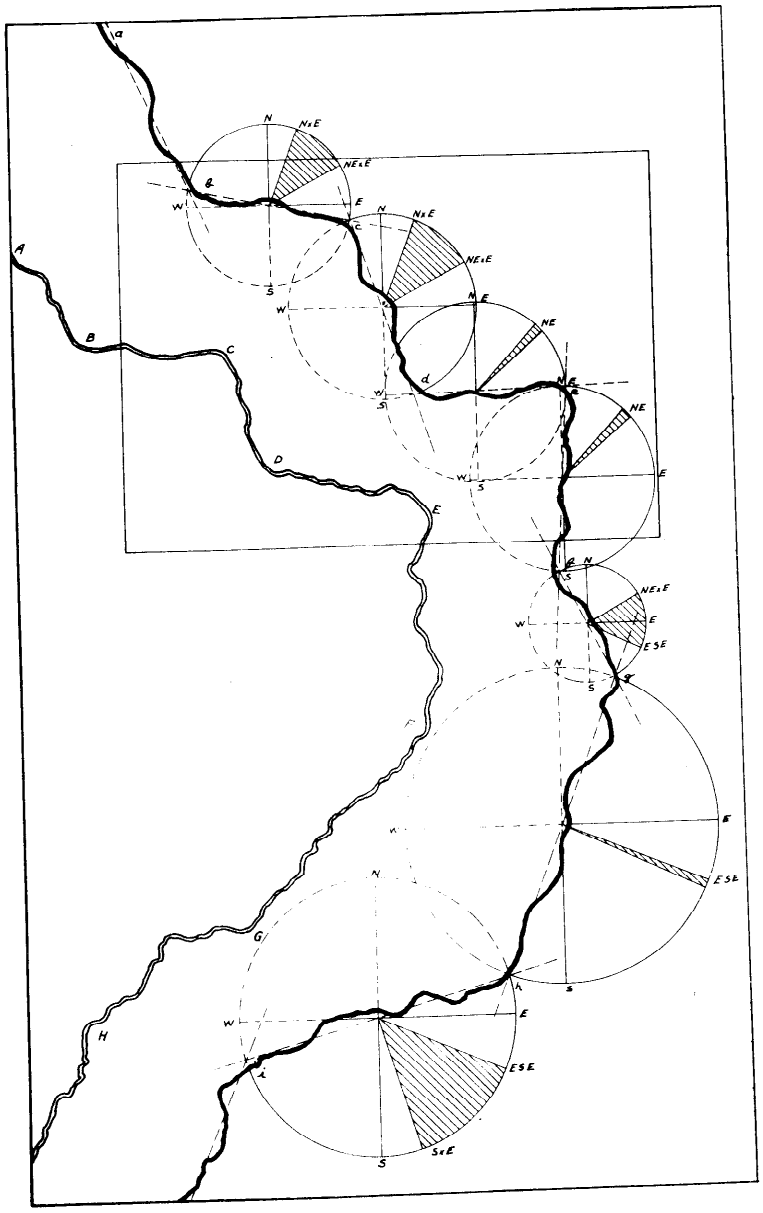

Fig. 34.

Wind Map.

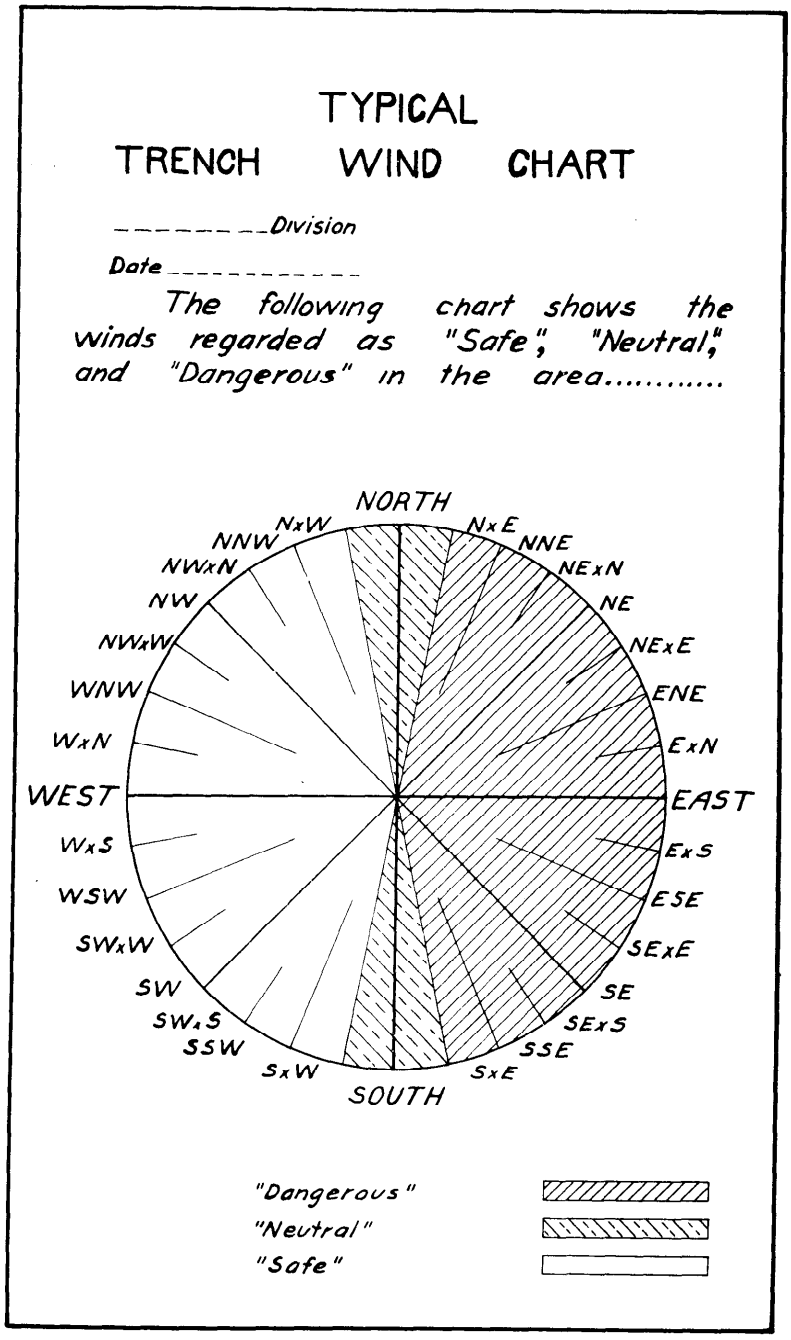
TYPICAL
TRENCH WIND CHART
_____Division
Date_____
The following chart shows the winds regarded as "Safe", "Neutral," and "Dangerous" in the area.....
NORTH
NxE
NNE
NExN
NE
NExE
ENE
ExN
EAST
ExS
ESE
SExE
SE
SExS
SSE
SxE
SOUTH
SxW
SSW
SWxS
SW
SWxW
WSW
WxS
WEST
WxN
WNW
NWxW
NW
NWxN
NNW
NxW
"Dangerous"
"Neutral"
"Safe"

Fig. 35.

These reports involve the consideration of the following:

138. The Wind Vane.—A simple wind vane must be set up. **The wind vane must have as little friction as possible,** so that a wind of under two miles per hour will turn it. It should carry a strip of linen 5" x ¾" (the Beaufort Flag), by the movements of which the strength of the wind can be judged. A wind vane that can be easily made in the field is shown in Fig. 36.

Correct orientation is obtained by getting North by the North Star and South by the sun at midday.

Wind vanes must be set up sufficiently high to get a true observation (e. g., 18 inches above the top of the dugout, etc.), but it must be remembered that an obtrusive wind vane is liable to draw fire and the simplest possible type must be adopted. A very simple form of vane, which is sufficiently sensitive and accurate, is formed by attaching a tuft of cotton to the end of a short length of thread which is tied at the top of a short pole, the points of the compass being laid out on the ground.

139. Direction of the Wind.—Before reading the direction of the wind from the vane the observer should gauge the approximate direction by noting the course taken by smoke, etc. Direction of wind must be stated in points of the compass, as shown in Fig. 35.

140. Strength of Wind.—Anemometers of sufficient sensitiveness to measure the strength of the wind with accuracy are too delicate to employ in front line trenches. With a little practice the strength of the wind can be gauged with sufficient accuracy by means of Beaufort's Scale.

Beaufort's No.	Speed in m.p.h.	Observations of natural objects	Behavior of flag at top of vane
0	0	Smoke straight up.	No movement.
1	2	Smoke slants.	No movement.
2	5	Felt on face.	Slight.
3	10	Paper, etc., moved.	¼ up.
4	15	Bushes sway.	Up and falling often.
5	20	Wavelets on water; tree tops sway.	Up and falling less often.
6	30	Trees sway and whistle.	Up and flapping.

141. Warning Available.—The following simple calculation determines the number of seconds which it will take

for a gas cloud to move from the enemy's lines to our own:

Double trench distance (in yards) and divide by speed of wind (in m. p. h.).

$$\text{Example} = \frac{100 \times 2}{10} = 20 \text{ seconds.}$$

142. German Meteorological Service.—The following extract from a captured German document shows the enemy's dispositions for obtaining meteorological information:

"In the area occupied by each battalion in the front line there is a forward weather-observation station provided with three men, who hourly observe the wind direction and strength at a height of 0.5–1 metre above the surface of the earth. The results are communicated daily to the Field Meteorological Station at Army Headquarters, which in turn decides from these results and from the weather charts whether the weather conditions are favorable to an enemy gas attack and whether such an attack is possible or not. These decisions are communicated every evening to the headquarters of Army Corps and divisions. Should the Field Meteorological Station consider during the day that the weather conditions have become more favorable for a hostile gas attack, divisions are again warned about 12 noon or 6 P. M.

143. "These gas-attack warnings only refer to the front of one Army Corps. Showers of rain which, in general, prevent a gas attack are not taken into account in the reports, which are concerned only with the direction and strength of the wind. It is, of course, possible that on isolated short lengths of front wind currents may occur which may be favorable to the enemy. The troops themselves must, therefore, be on the lookout for the possibility of a gas attack. For this purpose small weather-cocks are advantageously arranged on each company front to show the wind direction at a height of about one meter above the ground. The sector commander decides, from the lie of the trenches, within what limits of the direction and strength of the wind it is desirable to have hourly reports from the forward observation posts. The observers themselves merely report on the direction and strength of the wind and are not in a position to state whether a gas attack is likely to occur. This decision

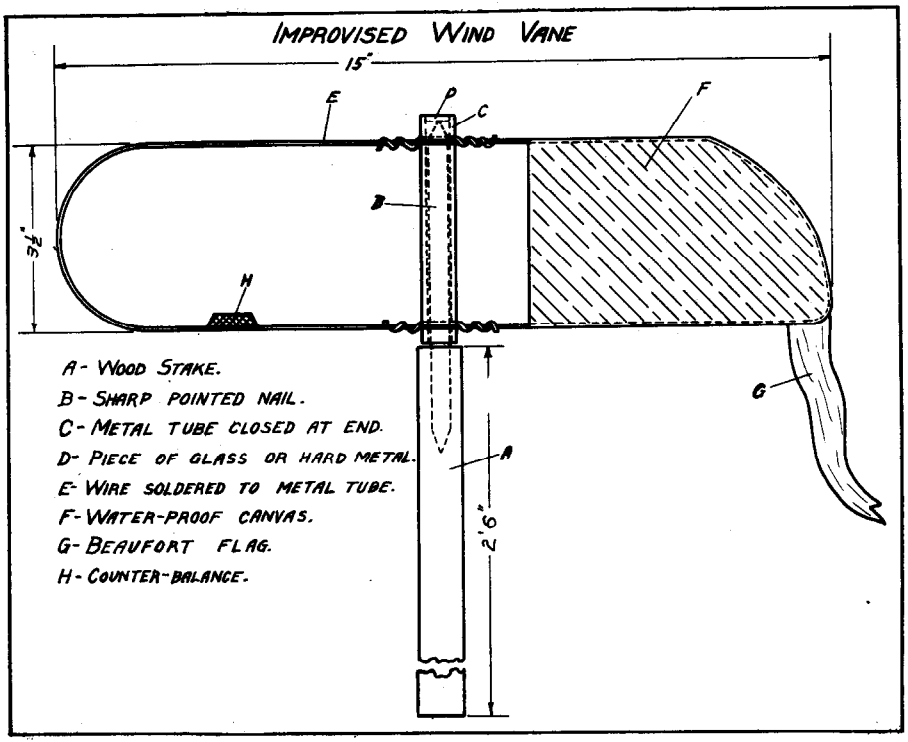
IMPROVISED WIND VANE
15"
E
D
C
F
B
3"
H
A - WOOD STAKE.
B - SHARP POINTED NAIL.
C - METAL TUBE CLOSED AT END.
D - PIECE OF GLASS OR HARD METAL.
E - WIRE SOLDERED TO METAL TUBE.
F - WATER-PROOF CANVAS.
G - BEAUFORT FLAG.
H - COUNTER-BALANCE.
A
2'6"
G

Fig. 38.

is the duty of unit commanders (battalion commanders, etc.) and is to be made as a result of the various reports. According to the probability, possibility or impossibility of a hostile gas attack, arrangements are made for the anti-gas preparedness of the troops."

(B) GAS ALARM.

(a) Cloud Gas Alarms.

144. In the event of a hostile cloud gas attack sentries must at once give the alarm by all means available—by gongs, rattles, etc., telephone, and, if necessary, by orderly. In order to prevent the spreading to the rear of false alarm Strombos horns should be sounded only when the sentry in charge is instructed to do so by an officer or non-commissioned officer or when he himself is aware that a cloud gas attack is being made.

145. Sentries must be prepared to give the alarm on the first appearance of gas, as a few seconds delay may involve very serious consequences. Signals must, therefore, be passed along by all sentries as soon as heard. Everyone in the trenches, dugouts, observation posts and mine-shafts must be immediately warned.

146. The earliest warning of a gas attack is given:

(a) By the noise of the gas escaping from the cylinders.

(b) By the appearance of a cloud of any color over the enemy's trenches. If the attack takes place at night the cloud will not be visible from a distance.

(c) By the smell of the gas in advanced posts.

147. If the gas cloud is unaccompanied by an infantry attack no S. O. S. signal should be sent, but the letters G. A. S. telephoned or telegraphed, followed by the name of the trench opposite to which the gas is being liberated.

This message must not be sent in case of a gas shell bombardment.

148. Arrangements must be made for an immediate report of a hostile cloud gas attack to be sent to all formations within twenty miles, giving the map reference of the point of attack as follows:

Divisions should arrange to warn:

Corps Headquarters.

All other divisions of the same corps.

(If a flank division) neighboring division of adjoining corps.

Corps should arrange to warn
Army Headquarters.
All other corps of the same army.

(If a flank corps) neighboring corps of adjoining army.

Arrangements must be made for the warning to be repeated, where necessary, to an officer in each village or camp within a radius of twenty miles of the point of attack, who will be responsible for warning units billeted there.

Corps must arrange to warn civil authorities, who are responsible for the protection and warning of all civilians within the corps area.

149. Action to Be Taken on the Alarm Being Given.—Everyone must at once put on a respirator. Men in dugouts must do this before leaving the dugouts.

Troops in the front line and wherever the tactical situation requires it must stand to arms.

With the exception of sentries and of officers and non-commissioned officers on duty, there is no objection to troops in rear lines remaining in dugouts if the tactical situation permits it.

The blanket curtains of protected dugouts and cellars must be properly adjusted and fires in such dugouts put out at once.

All bodies of troops or transport on the move should halt and working parties should cease work until the gas cloud has passed.

If a relief is in progress, units should stand steady as far as possible until the gas cloud has passed. Supports and parties bringing up ammunition and grenades should be moved up only if required for tactical reasons.

(B) GAS SHELL ALARMS

150. Owing to the small explosion which occurs with these shells they are liable to be mistaken for blinds, and even when the gas is smelt men may not realize its possibly dangerous character at once and so may delay putting on respirators or helmets until too late. Men sleeping in dugouts may be seriously affected unless they are roused. Men in the open air are unlikely to be seriously affected by poison gas

shells, provided they put on respirators or helmets on first experiencing the gas. The following points should, therefore, be attended to:

(i) On the alarm being given or at the first signs of a gas shell bombardment **of any kind** the breath must be held and respirators put on **at once.**

Particular attention must be paid to all shells which burst with a small detonation

(ii) The alarm must be spread immediately to everyone in the danger zone:

(a) By gongs, bells, rattles, etc.

(b) By men shouting "Gas shells" after masks have been adjusted.

(c) By any other means available (runners, if necessary), except that Strombos horns must **on no account** be used to give the alarm.

(iii) Dugouts must be visited, sleeping men roused, gas-proof blankets adjusted and any fires in protected dugouts put out.

(C) PROJECTOR ALARMS.

150a. The simultaneous firing of a large number (several hundred) of Trench Mortar shells, a method recently adopted by the Germans and copied from the British, may necessitate such attacks being viewed as gas cloud attacks. The amount of gas used is very large and may produce a cloud comparable in size with that from a cylinder attack. Such an attack may be felt several miles behind the front line.

150b. The very high concentrations of gas produced locally by such methods render rapidity in obtaining protection imperative. Warning is obtained by the extensive flash and the loud noise of discharge. The alarm must be given as soon as these signs are recognized.

(C) ACTION DURING A GAS ATTACK.

(a) Cloud Gas.

151. Protective Measures.—THERE SHOULD BE AS LITTLE MOVING ABOUT AND TALKING AS POSSIBLE IN THE TRENCHES. MEN MUST BE MADE TO REALIZE THAT OBSERVANCE OF THIS MAY BE ESSENTIAL FOR THEIR SAFETY.

If troops in support or reserve lines of trenches remain in, or go into, unprotected dugouts they must continue to wear

their respirators.

Officers and non-commissioned officers must on no account remove or open the face-pieces of their respirators to give orders. The mouthpiece should be removed from the mouth when it is necessary to speak, but it must be replaced.

Men must always be on the lookout to help each other in case a respirator is damaged by fire or accident. When a man is wounded he must be watched to see that he does not remove his respirator until he is safely inside a protected shelter; if necessary, his hands should be tied.

Men must be warned that if they are slightly gassed before adjusting their respirators they must not remove them. The effect will wear off.

152. Tactical Measures.—From the point of view of protection against a gas cloud, nothing is gained by men remaining in unprotected dugouts or by moving to a flank or to the rear. It is, therefore, desirable that on tactical and disciplinary grounds all men in the front line of trenches should be forbidden to do these things. In support or reserve line, where there are protected dugouts, it is advisable for men to stay in them unless the tactical situation makes it desirable for them to come out.

Nothing is gained by opening rapid fire unless the enemy's infantry attacks. A slow rate of fire from rifles and occasional short bursts of fire from machine guns will lessen the chance of their jamming from the action of the gas and tends to occupy and steady the infantry.

It should be remembered that the enemy's infantry cannot attack while the gas discharge is in progress and is unlikely to do so for an appreciable time—at least ten minutes—after it has ceased. It is, in fact, a common practice for the enemy infantry to retire to the second and third line of trench while gas is being discharged. There is, therefore, no object in opening an intense S. O. S. barrage of artillery on "No Man's Land" during the actual gas cloud, and it is advisable that the warning to the artillery of a gas attack should be a signal differing from the ordinary S. O. S. signal, as the latter may have to be sent later if an infantry attack develops.

It must be remembered also that smoke may be used by the enemy at the same time as, or alternately with, the gas and that under cover of a smoke cloud he may send out assaulting or raiding parties. A careful lookout must, therefore, be kept; hostile patrols or raiders may be frustrated by

cross-fire of rifles and machine guns, and should an assault develop the ordinary S. O. S. procedure should be carried out.

153. Artillery Action.—During the gas discharge a heavy artillery fire on the actual trenches whence the gas is issuing is the best way of dealing with the situation. Also, it is essential that the gas discharge should be interfered with as **early as possible,** as the opening periods of the discharge are the most effective.

To ensure an effective and immediate artillery fire the following points require attention:

(a) Certain batteries should be detailed to open a rapid fire for a short time as a defensive measure.

(b) As already explained, only certain portions of the enemy's front trenches can be used for gas discharge in any given wind, and these can easily be indicated on any accurate trench map. (See Fig. 34.) Each battery charged with the task of hampering an enemy gas attack should be provided with such a map and a table, showing from what portions of the enemy's lines (within the Battery's zone of action) gas can be discharged in any given wind.

Nothing in the foregoing paragraphs in any way affects the responsibility of artillery for dealing with any infantry attack, or for the execution of counter-battery work.

(b) Gas Shell Bombardment.

154. Protective Measures.—All precautions laid down with regard to a cloud gas attack must be observed, with the following in addition.

(i) Respirators should continue to be worn throughout the area bombarded with poisonous gas shells until the order is given by the local unit Commander to remove them.

(ii) Care must be taken that men do not enter protected dugouts if their clothing is contaminated with gas.

(iii) Sentries must be posted at suitable points to warn men to put on their respirators before entering the shelled area. These sentries must not be withdrawn until the area is free from gas.

(D) ACTION AFTER A GAS SHELL BOMBARDMENT OR CLOUD GAS ATTACK.

155. General.—THE MOST IMPORTANT MEASURE TO BE TAKEN AFTER A GAS ATTACK IS TO PREPARE FOR A FURTHER ATTACK.

Since the enemy frequently makes intermittent gas shell or trench mortar bomb bombardments and cloud gas attacks, made at intervals varying from a few minutes up to several hours, it is necessary to be on the alert to combat this procedure. The following measures should be adopted as soon as bombardment has ceased or the gas cloud has passed:

156. Removal of Respirators.—Canvas trench fans should be used to assist in clearing the trenches of gas, so that respirators can be taken off. Respirators must not be removed until permission has been given by an officer, who will, when possible, ascertain from officers and non-commissioned officers who have been trained at a gas school that it is safe to do so.

A sharp lookout must be kept for a repetition of the gas attack.

157. Movement.—Owing to the enemy gas sometimes causing bad after-effects, which are intensified by subsequent exertion, the following points should be attended to:

(a) No man suffering from the effects of gas, however slightly, should be allowed to walk to the dressing station.

(b) The clearing of the trenches and dugouts should not be carried out by men who have been affected by the gas.

(c) After a gas attack, troops in the front trenches should be relieved of all fatigue and carrying work for 24 hours by sending up working parties from companies in rear.

(d) Horses which have been exposed to the gas should not be worked for 24 hours if it can be avoided.

SPECIAL PRECAUTIONS AFTER A GAS SHELL BOMBARDMENT.

158. General.—The gas may remain on the ground in liquid form for several hours after a bombardment. When it is impossible to withdraw men from an infected area, res-

pirators must be worn until it is certain that the ground is clear. Closed spaces such as dugouts and cellars may retain gas for many hours and must be thoroughly ventilated by means of fires. Men must not enter such places without wearing respirators until permission has been given by an officer.

When a man is close to the burst of a gas shell, his clothes may become contaminated with the liquid. When possible they should be removed and exposed to the air. Care must be taken that men sleeping in closed spaces are not gassed by long exposure to small quantities of gas brought in on their clothing or equipment.

Transport must move out of the shelled area when possible.

159. Mustard Gas.—(Dichlorethyl Sulphide.)—Mustard gas, which is very largely used in shells by the enemy, is very persistent and will render an area dangerous for as long as two days. Shelters and dugouts into which this gas has penetrated or has been carried by clothing and equipment should, therefore, if practicable, be temporarily evacuated. Men who remain in the shelled area or dugouts must wear their respirators continuously.

Occupants of entire dugouts have been gassed from two or three men who, having been exposed to mustard gas, had entered the dugout. Medical officers have been gassed while attending gassed cases.

For all these reasons it is imperative that the clothing of gassed cases be removed entirely. The patient must, however, be at once reclothed with warm clothing or covered with unaffected blankets, as chilling of the patient must be avoided by all means. Clothing washed in a four per cent. solution of chloride of lime is free from the gas; the clothes should then be washed in pure water, and later in a dilute solution of hyposulphite of soda to destroy the chlorine.

160. Treatment of Shell Holes.—Various methods have been tried for the treatment of shell holes in order to destroy gas remaining in the ground and thus causing danger and annoyance.

161. German Methods.—For lachrymatory shells the Germans have recommended the use of pyridine to hasten the removal of the noxious substance, but the method is neither very practical nor effective and seems to have fallen into

abeyance. The pyridine is sprayed over the ground impregnated with the tear gas and then brought into as close contact with the latter as can be managed. The effect of the lachrymator begins to disappear after one or two hours. The unpleasant smell of the pyridine is removed by the application of excess of water.

For poisonous gas shells (e.g., phosgene) the enemy recommends spraying the ground with milk or lime, which is applied by means of a switch made of twigs. The treatment is probably unnecessary, as the gas does not remain long in the open.

162. Treatment with Earth.—The best general method for dealing with gas shell holes is to cover them with at least a foot of fresh earth. Shell holes so treated should not be disturbed, as the chemicals are not thereby destroyed, and some of them disappear only very slowly.

163. Mustard Gas Shell Holes.—Chloride of lime (bleaching powder) freely spread on the ground destroys the gas. If not enough is used, the gas near the surface is destroyed, but that which has soaked in is not. Hence, ground so treated should not be again dug up. Men not wearing masks have been gassed from digging around such areas.

Fresh earth may also be used for treating mustard gas shell holes, as above, but in all cases men must wear respirators when doing such work.

164. Cleaning Arms and Ammunition.—Rifles and machine guns must be cleaned after a gas attack and then re-oiled. Oil cleaning will prevent corrosion for twelve hours or more, but the first available opportunity must be taken to dismantle machine guns and clean all parts in boiling water containing a little soda. If this is not done, corrosion continues slowly even after oil cleaning, and may ultimately put the gun out of action.

Ammunition should be carefully examined after a gas attack. All rounds affected by gas must be immediately replaced by new cartridges and the old ones cleaned and expended as soon as possible.

All hand and rifle grenades exposed to the gas should have their safety-pins and working parts cleaned and re-oiled.

All bright parts of guns and trench mortars, together with all accessories and spare parts exposed to the gas, must be

cleaned and wiped dry as soon as possible after the attack, and in any case within 24 hours, after which they should be thoroughly coated afresh with oil. The same applies to ammunition which may have been exposed to the gas.

Ammunition which, for any reason, had not been oiled must be cleaned and oiled and expended as soon as possible.

165. Cleaning Telephone Instruments After a Gas Attack.—After a gas attack, telephone apparatus that has been exposed to gas should be treated as follows:

The ends of the wires should be removed from the terminals and cleaned by being scraped with a knife, wiped with a damp cloth and dried. Terminals, exchange plugs and all exposed metal work should be cleaned first with a damp and then with a dry cloth. This process should be repeated after 12 hours have elapsed. The metal work of leather cases of telephones and of other instrument cases should be cleaned with oil in the same way as rifles, etc. The internal portions of the instruments should not be interfered with. If an instrument has been kept closed or covered up it is very unlikely that internal portions will have suffered: but if these portions show signs of corrosion the instruments should be sent back to Headquarters to be dealt with by an Instrument Repairer.

(E) PRECAUTIONS TO BE TAKEN WITH REGARD TO OUR OWN USE OF GAS.

166. Protection of troops is necessary during our own gas attacks. Adequate protective measures should always be possible, as arrangements can be made in advance and the element of surprise can be excluded. The following points should be noted:

167. Handling Gas Cylinders and Canisters.—Men engaged in handling gas cylinders, canisters, shells, bombs, etc., should carry their box respirators in the "Alert" position at whatever distance they are from the line.

168. Action When Gas Cylinders or Projectors Are in Position in Trenches.—If a cylinder or canister is burst by shell-fire, men should retire up-wind for a short distance. Dugouts in the neighborhood of the burst must be evacuated at once.

169. Action During Our Gas Attacks.—(a) All Commanders of units in the neighborhood must be warned when a gas attack from cylinders or projectors is contemplated. If a cylinder or canister is burst by shell-fire, men in the neighborhood should retire up-wind for a short distance. Dugouts in the neighborhood of the burst must be evacuated at once.

(b) It is advisable that all troops, except those whose presence is considered absolutely necessary, should be withdrawn from the trenches in which gas is installed before the attack is made. Any officer or man who has special orders to remain must wear his respirator.

(c) All troops in any part of the line within half a mile of the nearest point where gas is being discharged must wear their respirators.

(d) If troops advance after a gas attack has been made, it must be remembered that the gas may hang about for a considerable time in long grass, shell holes and hollows, and for several hours in the enemy's shelters. Dugouts should not be occupied until they have been thoroughly ventilated and the absence of gas established. This is equally necessary with regard to shelters which have been penetrated by gas from shells or bombs.

170. Gas Shells, Bombs and Grenades.—These may, if necessary, be stored with other ammunition. In the event of leakage they should be buried in the ground 3 feet deep. They should not be thrown into water. All rescue work and disposal of leaky shells should be carried out by men wearing respirators.

VII. EXPLOSION AND MINE GASES.

171. When black powder and many "smokeless" powders explode there is formed the poisonous carbon monoxide which is colorless and without smell or taste. When breathed it produces headache, dizziness and loss of consciousness, frequently culminating in death. The effect takes place almost instantaneously when large quantities of the gas are present in the air, as, for instance, in isolated cases, after the explosion of a "direct hit" in a dugout. If only a little carbon monoxide is present the poisoning may take place only after several hours. One-half per cent. of carbon

monoxide in the air is harmful after breathing the mixture for a long time. After the explosion of mines, the carbon monoxide percolates gradually through the soil, into the mine-galleries, and may be the cause of poisoning there after several days, without there being the slightest trace of the smell which is peculiar to the fresh explosion gases. Poisoning by the gases produced by explosions is treated by breathing oxygen. **The oxygen breathing apparatus is the only certain protection against explosion-gases.** Tunneling companies are again reminded that the respirator does not protect against carbon monoxide.

APPENDIX.

STANDING ORDERS FOR DEFENSE AGAINST GAS.

Issued to American Expeditionary Forces in France.

1. **Carriage of Respirators.**
   (a) **Within 12 miles of the front line** a box respirator **or** mask will always be carried.
   (b) **Within 5 miles of the front line** a box respirator will always be carried, and every man will be clean-shaven excepting that a mustache may be worn.
   (c) **Within 2 miles of the front line and within areas specially exposed to gas shelling,** the box respirator and mask will always be carried. The respirator will be carried in the "Alert" position. It will be worn outside all clothing, and nothing will be slung across the chest in such a way as to interfere with the quick adjustment of the respirator. The chin strap of the steel helmet will be worn on the **point** of the chin.
   (d) Military Police will report all cases of infringement of the above orders.
   (e) The above-mentioned lines will be conspicuously marked by each Corps, in such manner as to attract the attention of persons entering the above areas.
   (f) When not carried in the "Alert" position, the box respirator will be carried over the left hip, the sling passing over the right shoulder. Nothing shall be worn so as to interfere with the immediate **shifting** of the respirator to the "Alert" position. If the mask is also carried, it will be over the right hip, so as not to interfere with shifting the box respirator to the "Alert" position, the sling passing over the left shoulder, **but under** the sling of the respirator.
2. **General Precautionary Measures.**

Within the two-mile limit the following will be observed:
   (a) Box respirators will be inspected **daily.**
   (b) Gas N. C. O.'s will inspect daily all gas alarm appliances and anti-gas stores. They will see that gas-proof dugouts are in good order and the blankets kept moist.

(c) All sentries will act as Gas Sentries and will be provided with alarm appliances to give warning in case of gas shelling or a gas cloud attack.

(d) Each sentry group will have a definite area to alarm in the event of a gas attack or bombardment.

(e) Sentries must be posted to give warning to men in dugouts.

(f) All working parties of 10 or more men will have a sentry posted to give warning in the event of gas being used by the enemy.

(g) Precautions will be taken to protect ammunition from the corrosive action of gas.

(h) Stores of fuel will be kept for clearing dugouts.

(i) Units in the line will make wind observations and sentries will be warned to be on the alert for signs of cloud gas **whenever the wind is in a dangerous quarter.**

In the area between two and twelve miles from the front line the following will be observed:

(j) Anti-gas appliances will be inspected at least once a week and immediately before men proceed to any point within the two-mile limit.

(k) All sentries, traffic control men, military police, etc., when on duty, will act as gas sentries and will be provided with suitable alarm devices where necessary.

(l) Men may be allowed to take off their respirators when sleeping, but must keep them within reach.

(m) Arrangements will be made by Commanders of units and Area Commanders to communicate a gas alarm rapidly to all ranks.

3. Action to be taken in the event of an enemy gas shell or Trench Mortar Bombardment.

(a) At the first sign of gas shell of any kind or on hearing the alarm, the breath must be held and the respirator adjusted immediately, without waiting until the presence of gas is recognized.

(b) The alarm will be spread immediately to all troops in the neighborhood:

(1) By gongs, rattles or Klaxons.

(2) By shouting "Gas shells"—after the respirator has been adjusted.

(3) By runners where necessary.

Strombos horns will **not** be used.

Men in dugouts, observation posts and mine shafts must be warned, and sleeping men roused.

(c) Gas-proof dugouts will be closed immediately, and any fires burning in such dugouts put out. Care must be taken that men do not enter protected dugouts if their clothing is contaminated with gas.

(d) Sentries will be posted at suitable points to warn men to put on their respirators before entering the shelled area. These sentries will not be withdrawn until the area is free from gas.

4. **After a gas shell or Trench Mortar Bombardment the following precautions will be observed.**

(a) RESPIRATORS WILL BE WORN UNTIL PERMISSION TO REMOVE THEM IS GIVEN BY AN OFFICER.

(b) Gas may remain in liquid form on the ground for several hours after a bombardment. When it is impossible to withdraw men from an infected area, respirators will be worn until the ground is clear. **Gas Shell holes** will be **covered with fresh earth** when possible.

(c) Closed spaces such as dugouts and cellars may retain gas for several hours and must be cleared by means of fires. Men will not enter such places without wearing respirators until permission has been given by an officer.

(d) When a man is close to the burst of a gas shell his clothes may become contaminated with liquid. When possible the clothes will be removed and exposed to the air. Care must be taken that men sleeping in closed spaces are not gassed by long exposure to small quantities of gas brought in on their clothing or equipment.

(e) Men affected by gas will be spared exertion as much as possible and casualties will not be allowed to walk to the Dressing Station.

(f) Transport will move from the shelled area when possible.

5. **Action to be taken in the event of an enemy cloud gas attack.**

The Alarm.

(a) Alarm will at once be given by all means available; by Strombos horns, gongs, rattles, telephone, and, if necessary, by orderly.

Sentries will warn all ranks in the trenches, dugouts, observation posts or mine shafts.

(b) Sentries on Strombos horns will sound the horn: (1) when they detect **cloud** gas, (2) when they hear other Strombos horns sounding. Strombos horns will **not** take up the alarm from gongs and rattles.

(c) In order to restrict the spread of false alarms, when possible, Strombos horns in back areas will be placed so that they need not be sounded until the alarm is confirmed by telephone.

(d) Should the gas cloud be unaccompanied by an infantry attack, no S. O. S. signal will be sent, but the letters G. A. S. will be telephoned or telegraphed, followed by the name of the trench opposite to which the gas is being liberated. This message will not be sent in case of a gas shell bombardment only.

(e) Arrangements will be made for an immediate report of a hostile gas attack to be sent to all formations within 40 kilometers (25 miles), giving the map reference of the point of attack, as follows:

Divisions will warn:

Corps H. Q.

All other divisions of the same corps.

(If a flank division) neighboring divisions of adjoining corps.

Corps will warn:

Army H. Q.

All other corps of same army.

(If a flank corps) neighboring corps of adjoining army.

(f) Arrangements will be made for the warning to be repeated where necessary, to an officer in each village or camp within a radius of 40 kilometers of the point of attack, who will be responsible for warning units billeted there.

(g) Corps will arrange to warn civil authorities who are responsible for the protection and warning of all civilians within the corps area.

Action on the Alarm being given.

(h) THERE SHOULD BE AS LITTLE MOVEMENT AND TALKING AS POSSIBLE. All ranks will at once adjust their small box respirators. Men in dugouts will do so before leaving dugouts.

(i) The blanket curtains of protected dugouts and cellars will be properly adjusted, and fires in such dugouts put out.

(j) Troops in the front lines, and wherever the tactical situation demands, will stand to arms.

(k) In rear lines there is no objection, where the tactical situation permits, to troops, with the exception of sentries and of officers and N. C. O.'s on duty, remaining in dugouts.

(l) All bodies of troops or transport on the move will halt, and working parties will cease work until the gas cloud has passed.

(m) If a relief is in progress, units should stand steady as far as possible until the gas cloud has passed.

(n) Supports and parties bringing up ammunition and grenades will only be moved up if the tactical situation demands.

Action during an Enemy Cloud Gas Attack.

(o) The troops in the front trenches will open a slow rate of rifle fire at once against the enemy's trenches, and occasional short bursts will be fired from machine guns to ensure that all weapons are in working order.

(p) Corps will arrange a suitable artillery programme to be carried out in the event of a cloud gas attack.

Action after an Enemy Cloud Gas Attack.

(q) Trenches will be cleared of gas with anti-gas fans and sandbags.

(r) Respirators will be worn until permission to remove them is given by an officer.

(s) **A sharp lookout will be maintained for a repetition of the attack as long as the wind continues in a dangerous quarter. Men will sleep on the fire-step within reach of a sentry.**

(t) The instructions given in Section 4 (c) above, with regard to entering dugouts, etc., will be observed.

(u) No man suffering from the effects of gas will be allowed to walk to the Dressing Station.

(v) The clearing of trenches and dugouts must not be carried out by men who have been affected by the gas.

(w) After a gas attack, troops in the front trenches are to be relieved of all fatigue and carrying work for 24 hours, by sending up working parties from companies in the rear.

(x) Horses which have been exposed to the gas will not be worked for 24 hours if it can be avoided.

(y) Rifles and machine guns must be cleaned after a gas attack. Oil cleansing will prevent corrosion for 12 hours, but the first opportunity must be taken to clean all parts in boiling water containing a little soda.

(z) Small arms ammunition must be carefully examined. All rounds affected by the gas must be replaced by new cartridges immediately, and will be cleaned. Especial attention must be paid to the brass clips.

(zz) Expended air cylinders of Strombos horns will be replaced by full ones.

6. Anti-Gas Trench Stores.

(a) These comprise:

Extra supply of respirators and masks (5 per cent. of strength).
Strombos horns and other alarm devices.
Wind vanes.
Gas-proof coverings for dugouts.
Anti-gas fans.
Stores of fuel for clearing dugouts.
Vermorel sprayers.
Gas sampling apparatus.

(b) Commanders of formations or units relieving one another are responsible that trench stores are duly turned over and receipted for and that they are in good condition and in proper positions for use or replacement.

(c) The actual taking over should be done by company (battery) Gas N. C. O.'s, who will go up with the advanced party (if possible in daylight) for this purpose. They will report any defects to their Company (battery) commander.

(d) As soon after the actual taking over as possible the Battalion Gas Officer will make an inspection of all anti-gas arrangements and stores. He will call the attention of Company Commanders to any defects or deficiencies for correction.